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with the surface by a proper knife or chisel, and the table being screwed down one or more divisions (as shown in drawing No. 3), a section is cut, which, if found of sufficient thinness, a number of sections may be cut by continuing to turn the table down a similar number of divisions, until it will screw no further, when the table must be again screwed up and the wood loosened and raised, if more sections are required. The principal points of the instrument are:

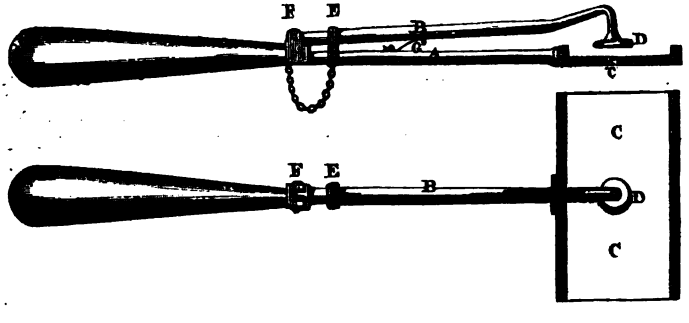
1st. Its portability; the tube being about two and a half inches long by one inch in diameter.

2d. That the specimen to be cut is fixed once for all, and the cutting-surface screwed down to it, a feature that will render it peculiarly applicable to the cutting of soft substances.

3d. The ease with which a number of sections may be cut without disturbing the specimen when once properly fixed, while the size of the tube, and the facility with which it can be adapted to specimens of various diameters, enable the operator to get sections of stems of plants, &c., whole. In cutting sections of hard woods, which require considerable purchase, it is proposed to place the instrument in a semicircular opening in the edge of the working-table, so that the flat plate or cutting-surface may rest upon it, and the strain thrown on the table, as represented in drawing No. 3. When cutting soft substances it can be held in the hand.

The Mounting Instrument.

This instrument, as shown in the drawings, consists of a brass rod (A), with a handle at the one end, while the other terminates in a flat brass plate (C), one inch wide by two or three long, slightly turned up at the sides for the purpose of



holding the slide; another arm (B) is joined by a hinge to the first at F, and terminates in a small disc (D), which comes

down in the centre of the flat plate, a spring (G) keeps the two arms apart, and, where permanent pressure is required, a loose ring (E) (or, if found more convenient, a small screw) keeps the upper arm in a fixed position by sliding it up as far as it will go.

To use the instrument the object to be mounted is placed dry on the glass slide, which is put in the plate or holder, and a thin glass cover being placed on it the upper arm is pressed down, bringing the small disc upon the thin glass cover and holding it in its place during the process of mounting; a sufficient quantity of balsam being put at the side of the cover, the instrument is held over the flame of a lamp and sufficient heat applied to melt the balsam, which runs in by capillary attraction.

The advantages offered by this process being the facility with which specimens can be mounted, as well as that objects of great delicacy can be placed on dry, and the balsam then run in without in any way disturbing their several parts; a slight extra pressure also frequently serves to disperse the air-bubbles entirely from the specimen.

In the mounting of Marine Algæ, &c., by this process, with a gelatine medium (Deane's), the specimen can be laid on the glass with a small quantity of water, and properly arranged in it, the glass cover being then put on, and a sufficient quantity of the medium placed at the side of it; when heat is applied, the gelatine drives out the water and leaves the object mounted.

Observations *on* "Granulated" Blood-discs.

By George F. Pollock, Esq.

(Read June 29th, 1859.)

When a drop of blood, taken from any part of the human body, is examined by the microscope with a suitable power, say from 300 to 600 diameters, every observer is aware that —besides the ordinary red discs of a flattened form, having a depression in the centre on both sides, with a circular and perfectly even outline—there are others of which the exterior surface is quite irregular. Some appear flat, with a crenated border. Some, approaching more or less to a spherical form, are covered with little tubercles, giving them a granulated or mulberry-like appearance. That these irregular discs are all formed from the circular ones can admit of no doubt. Indeed they have often been called degenerated blood-discs, and the change, as it takes place out of the body, may be observed under the microscope. The most convenient way of doing this, is to put a little oil or varnish round the edge of the thin glass cover under which the drop of blood is placed, which, by preventing its drying up, enables the examination to be continued for some time. In some discs the change takes place rapidly in the course of a few minutes, in others it never takes place at all, and the only change to be seen after the interval of a day or two is that they are smaller in size and less flattened in shape. The first change in a circular disc which is about to become granulated, consists in the appearance of spots where the exterior membrane seems thinner and more transparent than elsewhere, and it is at these spots that the granules or tubercles make their appearance. It would seem that these spots are caused more by a contraction of the intervening thicker portion of the membrane than by an expansion of the thinner portion, for the diminution in size, which is observed in all the discs after the lapse of some hours, takes place much more rapidly and to a greater degree in the granulated discs than in the others.

Together with the appearance of these spots the disc usually assumes a less flattened and more rounded shape. The granules are usually most numerous at the edge of the disc, where they are first observable, giving it a crenated appearance. Gradually, as they increase in size, the outline becomes sharper, till they sometimes present an almost spiked appearance. This change will be gone through in a period

varying from a few minutes to perhaps an hour. At, or perhaps rather before, the time when the granulated appearance is most distinct, minute holes may be observed in the extreme ends of the tubercles where they are thinnest. These holes gradually increase in size while the entire disc grows less. The membrane is so thin at the point, and the holes are at first so minute, that it is requisite to use a good object-glass to make them out satisfactorily; a superior fifth will do, but an eighth is better for the purpose.

After the lapse of some hours cracks begin to appear in the thicker part of the membrane between the tubercles, which gradually increase in width, till ultimately the disc separates into several pieces. If a little spirit of wine be added to the blood the entire change appears to take place instantaneously. Not a disc in any shape is to be seen, but there remains an abundance of extremely minute particles of no definite shape, apparently the débris of the former discs. These little particles I have frequently seen in recently drawn blood, which has been carefully preserved from all external contamination; and, indeed, I have frequently seen them in actual circulation in the living body, as I shall presently have occasion to mention.

The addition of mineral acids causes the discs to shrink up, and renders their outlines darker. Hydrochloric acid, especially when diluted, produces in many of the discs a disposition to adhere together, which gives to each disc a sort of double caudate shape, like two peas joined by their larger ends; they are attached to one another by the smaller ends, and on separation resume their circular form. Nitric acid produces a sort of riddled appearance in the discs, which become full of small holes, and also appear to have the outline eaten away in places. Liquor ammoniæ of ordinary strength dissolves the discs entirely, and they disappear at once. Those discs which are connected together in the form of rouleaux are much less disposed to undergo the change which I have described than those which are separate.

I have always been anxious to discover whether any change of this description takes place while the blood is alive in the body, which, for several reasons, I at first thought not unlikely, especially because, upon examining the blood, as quickly as it is possible to do after being drawn from the body, I have commonly found granulated discs in very different stages, some much more forward than others, looking as if the change in the latter had commenced before the blood was drawn. If the blood-discs, while in the body, did undergo a change in any degree similar to that I have

described, the final stage of the process, that is, the breaking-up of the individual discs—owing to the motion of the blood in circulation—might well be supposed to be more rapid and more complete; and this would account for the presence in blood of the minute particles before mentioned, which might then be regarded as the débris of previously existing discs. I have not, however, been able hitherto to detect any such alteration in the form of the discs while in actual circulation in the living body.

Having often seen changes of the same nature, though not quite similar in appearance, take place in the discs of blood taken from frogs and newts, I first tried carefully if I could discover any granulated discs in the blood while in actual circulation in the web of a frog's foot, examined in the ordinary way. I next tried the gills of the tadpole of the great water-newt (*Triton cristatus*), which, from their greater transparency, permit the individual blood-discs to be better seen. In neither instance could I perceive any granulated discs, though in both cases discs of an unusual form sometimes occurred. I next examined the blood while circulating in the arteries and veins of the mesentery in kittens and rabbits, while under the influence of chloroform, having, in most cases, previously examined the blood obtained by pricking the skin of the animal, and found an abundance of granulated discs. The membrane of the mesentery is so thin as to afford the fullest opportunity of examining the individual discs, when the circulation is sufficiently slow, but I have never been able to detect granulated discs while the animal has remained alive, though I have often seen an abundance of the small particles before described in rapid circulation. Almost immediately after the death of the animal, many of the discs begin to assume the granulated appearance, whilst others remain unchanged. Whatever be the cause of this difference (which may, perhaps, depend upon the age of the discs, the younger ones resisting the change), exposure to the air does not seem to have anything to do with it, for whether the effect of the air is, or is not, sensible through the very thin membrane of the mesentery, the discs in the smaller vessels are all equally exposed to that effect. I make this remark because, from the granulated discs being always found to be most numerous at the exterior edge when a drop of blood is covered with thin glass, some difference might be supposed to result from the outer ones being the most exposed to the air. This position of the granulated discs may, however, easily be shown to depend on mechanical causes; for if a piece of thin glass be raised at one end the thickness of

a hair, by means of a drop of dried varnish placed under the two corners at one end, and a drop of blood be then allowed to run underneath from the raised end, the irregular discs will at once be all found at the other end; they are smaller in size, usually free and detached; they present a rougher and more extended exterior surface, and they appear to be slightly inferior in specific gravity; when, therefore, what may be called a capillary rush of the fluid takes place, as it always does when a drop of blood is covered with thin glass, the granulated discs are naturally carried to the greatest distance. Again, there is no difficulty in obtaining dried blood free from granulated discs, which could hardly be the case if the change were occasioned by exposure to the air. If it be so, that no such changes as these ever take place while the blood is alive in circulation, the inquiry becomes comparatively uninteresting, though, even then, it may tend to throw light upon what is the ultimate structure of the discs; but having regard to the very different degree in which, after death, some of the discs evince a tendency to undergo the change as compared with others, while some resist it altogether; it would seem highly probable that there must be a corresponding difference of condition or structure during life, though, for the present, we may be unable to detect it. My opportunities have not enabled me to make comparison of the blood obtained from persons suffering under different forms of disease; but having examined it in persons of all ages and both sexes, obtained when the stomach has been full and when empty, after fatigue and after rest, and at all hours of the day, commonly by pricking the finger, but frequently from deeper incisions, and, in the case of rabbits and cats, obtained from various parts of the body, especially from the larger arteries and veins, I have never found an instance in which a drop of blood, placed under thin glass the instant it was drawn, and examined in the usual way, did not at once exhibit granulated discs in greater or less abundance, if not elsewhere, at all events at the exterior edge of the drop.

In conclusion, I need hardly say that the preceding observations are in no degree applicable to the white or colourless discs.

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SULLIVANT (W. S.). Musci Alleghanienses.

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W. G. SEARSON, *Curator.*

TRANSACTIONS.

On Campylodiscus, *&c.* By R. K. Greville, LL.D., F.R.S.E., &c.

(Communicated by F. C. S. Roper, F.L.S., &c.)

The short paper which I have now the honour of laying before the Society contains descriptions of new species of *Campylodiscus*, of singular beauty and great rarity. The materials have been accumulating on my hands for a considerable time; and as the illustrative figures are sufficiently numerous to fill a plate, I venture to offer them for publication. Amongst the drawings I had prepared, was one of *Campylodiscus striatus*, Ehrenb.; but Mr. Brightwell has subsequently well represented that species in Plate IX, vol. vii, of the 'Microscopical Journal.' It required to be correctly figured; for the original engraving in Ehrenberg ('Amer.,' tab. iii, vii, fig. 13), than which nothing can be more obscure, was the only one we possessed, for that given by Kützing ('Bacill.,' tab. xxviii, fig. 11) is merely a copy. Although very difficult to reconcile such a figure with the beautiful diatom itself, I believe Mr. Brightwell is correct in having done so. His station, as well as that given by Ehrenberg and Kützing, is Vera Cruz. My specimen was obtained from the washings of small algæ from Jamaica.

Campylodiscus Normanianus, n. sp., Grev.—Valve circular; canaliculi 3 to 4 in ·001", the centre occupied by a circumscribed linear-oblong depression, across which the canaliculi pass until they nearly meet. Diameter ·0045". Pl. I, fig. 1.

In cleanings of *Spondyli*; George Norman, Esq.

I have much pleasure in dedicating this very fine diatom to my friend, Mr. George Norman, of Hull, who directed my attention to it. He informs me that the shell from which he obtained the scrapings, yielding not only the present but two

other new forms, was no larger than a walnut. This may serve as a hint to conchologists into whose hands such shells as *Spondyli*, and others favorable to the incrustation of zoophytes, come in a rough state, not to throw away the scrapings and cleanings which may be necessary to prepare them for the cabinet. No locality was given with the shell in question; but the diatoms parasitic upon it furnish almost conclusive evidence that it came from the West Indies.

C. marginatus, Johnst.? ('Mic. Journ.,' vol. viii, Pl. I, fig. 11).—Valve nearly circular; canaliculi 5 in ·001″, less in length than half the radius, forming a narrow marginal band; central area elliptical-oval, filled with close, transverse, moniliform striæ, interrupted by a narrow median line of blank space. Diameter ·0023″. Fig. 2.

In scrapings of conch-shells, Nassau, New Providence; R. K. G. Californian guano; T. G. Rylands, Esq.

On this diatom, examined and drawn many months ago, I had bestowed the MS. name of *concinnus*; but it is probably the same as Dr. E. Johnston's *C. marginatus*, published in vol. viii of the 'Journal of Microscopical Science.' I am not, however, quite certain of this. There is a great difference in regard to size; his example × 300 diameters being much larger than mine × 400. I have seen several specimens all agreeing most closely in every particular. The introduction of my own figure in this place may serve to throw some light on the question, and to confirm the species.

C. imperialis, n. sp., Grev.—Valve circular; canaliculi more than one third the length of the radius, 3 in ·001″, forming a marginal band; central area broadly elliptical, filled with narrow, transverse, moniliform striæ, interrupted by a narrow median line of blank space. Diameter ·0055″. Fig. 3.

In scrapings of conch-shells, Nassau, New Providence.

The shell-cleanings in which I was so fortunate as to detect this truly splendid species, were kindly presented to me by Mr. George Norman. After cleaning and preparing them by the usual processes, I obtained sufficient material for mounting nearly twenty slides, and it is remarkable that almost every slide contains something peculiar to itself. In one slide only does a perfect example of the species now figured occur. In the general appearance of the marginal band it resembles *C. limbatus* of De Brébisson, but differs materially from that diatom on a closer examination. There is a sort of minute secondary band, composed of a series of bifid segments, alternating with the canaliculi at their base, which gives a highly ornate character to the margin. The

striation of the centre is somewhat obscure. The lines are fine, and rather close, and the moniliform character appears in certain lights to be produced by minute, subremote puncta, planted, as it were, on the striæ.

C. notatus, n. sp., Grev.—Valve nearly circular; canaliculi numerous, about 12 in ·001″, in length more than half the radius; central area an oval space, traversed vertically by a very thick bar, which is dilated and crescent-shaped at each end. Diameter ·0018″ to ·0023′. Fig. 4.

In cleanings of *Spondyli*; George Norman, Esq.

A very singular species, distinguished at once by the marking of the centre, which Mr. Norman aptly compares to the figure of a dumb-bell.

C. ambiguus, n. sp., Grev.—Valve nearly circular; canaliculi distant (about 22), reaching nearly to the centre, partially interrupted at about the middle of the radius; the centre furnished with an oblong depression, within which is a short, linear-elliptical median blank line. Marginal striæ 11 in ·001″. Diameter about ·0028″. Fig. 5.

In washings of small algæ from Jamaica; R. K. G. On *Spondyli* (fragment) in a slide communicated by Mr. George Norman.

An exceedingly curious species, presenting an aspect at once suggestive of an affinity with *Surirella fastuosa*. This is chiefly owing to the small number of the canaliculi, and to the singular interruption in their continuity. They are firm and strong at their internal extremity; and at a point about the middle of the radius, deviate slightly from the straight line, as if they were going to fork or become inflated, as in *Surirella fastuosa*. The margin, however, is that of a *Campylodiscus*, and the valve is very considerably curved. It is a highly graceful species.

C. diplostictus, n. sp., Norman.—Valve nearly circular; cellules linear-oblong, in pairs, forming long radiating lines, which at the margin alternate with one or two short ones. Diameter ·0055″ to ·0070″. Fig. 6.

From Ascidians, Shark Bay, on the west coast of Australia; Dr. Macdonald; kindly communicated by George Norman, Esq.

It will be immediately perceived that while this magnificent species approximates to *C. cribrosus*, it is strikingly distinct. In the species just mentioned, the cellules are, as described by Professor Smith, irregularly circular; in Mr. Norman's diatom they are regularly narrow oblong, so regular, in fact, as to form pairs throughout the whole length of the radiating lines; then, instead of the cellules being

laterally some distance apart, as in *C. cribrosus*, they are so closely united in *C. diplostictus* as to cause the lines to look like double filaments divided by transverse septa. The long lines, besides, alternate regularly at the margin with one, or occasionally two short ones, reminding the observer of the lamellæ of an Agaric. The shorter lines vary in length from a fourth to nearly a third of that of the long ones, which has the effect of causing the latter to seem very remote from each other at their inner extremity. The central blank space is more or less rounded or oval, and in size is usually somewhat less than a third of the entire diameter of the disc.

C. Kittonianus, n. sp., Grev.—Valve circular; canaliculi 3 in ·001″, more than half the radius, fringed with minute transverse striæ for two thirds of their length. Diameter ·0058″. Fig. 7.

On *Tridacna*, West Indies; F. Kitton, Esq. On *Spondyli*; George Norman, Esq.

This is the most remarkable species which has come under my observation. The canaliculi are exceedingly sharply defined, and are singularly conspicuous for about two thirds of their length, by being furnished with a sort of ridge or crest of minute striæ. In a vertical aspect (as in the middle canaliculi of the valve) these minute striæ entirely cross the part, and have the effect of increasing its diameter; but when viewed in profile, the striæ are seen to constitute a raised crest, very much resembling a long, narrow, one-sided brush, the naked portion of the canaliculus representing the handle. The valve is considerably curved and concave; and in the central space there is a broad vertical bar, dilated at top and bottom, as in *C. notatus*, only less conspicuous, and composed apparently of merely a thicker and more opaque substance than the rest of the central area. I apprehend, however, that no dependence can be placed on this character; for in several specimens of *Campylodiscus stellatus*, which I have recently had an opportunity of examining, through the kindness of Mr. T. G. Rylands and Mr. Kitton, no two are alike in the characters afforded by the central markings.

Of the noble species before me I observed a single fragment in one of Mr. G. Norman's slides obtained from the cleanings of *Spondyli*.

Notes *on* Diatomaceæ *found near* Gambia, O. By Professor Hamilton L. Smith, of Kenyon College, Gambia, O.

(Communicated by E. G. Lobb, Esq. Read Nov. 15, 1859.)

The few slides sent herewith may be acceptable to the Society as representatives of aquatic genera and species common in the interior of the United States. The slides are numbered at the right-hand top; they are mostly balsam mounted, a few are mounted dry, and a few in distilled water.

1. *Meridion circulare.*—Exceedingly abundant, and always found attached to the same conferva; it has occurred also with very long stipes, say three or four times the length of frustule. Generally, quick-running streams.

2. *Gomphonema anomalum*, n. sp.—This Gomp., to which I have attached the provisional name "anomalum," was found conjugating, single frustules producing single sporangia, contrary to the hitherto observed Gomphonema. The specimen was prepared by burning on the glass cover. It is same as No. 32.

3. *Gomphonema ovatum*, n. sp.—Found conjugating (same as No. 16), prepared by burning on the cover; double sp. I have given to this the provisional name "ovatum."

4. *Stauroneis.*—Supposed to be sporangia of *Phænecentera*; may be new, however, it is much coarser, and varies somewhat in outline.

5. *Surirella*, &c.

6. *Diatoma tenue.*—Prepared by burning.

7. *Cocconema cymbiforme.*—Found conjugating. (See after No. 40.)

8. *Gomphonema dichotomum*, &c.

9. *Gomphonema sarcophagus?* Greg.

10. *Eunotia*, &c.

11. *Collotonema vulgare.*—This is the diatom most abundant here, and is found in almost every stream. Striæ about 77 in ·001″; prepared by burning. It sometimes forms thick skins of several layers, and when placed in quiet water throws out little tufts or "papillæ" towards the light, almost colourless except at their summit, which becomes almost black by the aggregated diatoms; these papillæ are from $\frac{1}{8}$ to $\frac{1}{3}$ in. in length. No. 22 is the same in fluid, showing the curious encysting which sometimes occurs. This encysting is quite common among the diatoms, but has no relation to conjugation, as supposed by Smith, in S. B. D. (remarks on *S. radians*). No. 21, *S. capitata*, will be found to contain

bundles of once encysted masses, still adherent after boiling in acid. The phenomena attending this encysting I hope to present to the Society at some future period, and its significance.

12. *Cocconeis*, &c.

13. *Fragillaria capucina.*—Contains small distorted Synedra, and new Pinnularia; also Gomphonema, No. 2, and sp. frustules.

14. "Near centre run," five miles from Gambia.

15. *Synedra vitrea*, Kütz. ?

16. *Gomphonema.*—Same as No. 3.

17. *Himantidium*, &c.

18. *Meridion circulare.*

19. *Pinnularia—nova ?*—Resembles *Gibba* and *divergens.*

20. *Meridion constrictum.*—Found stipitate.

21. *Synedra captata*, &c.

22. *Collotonema vulgare.*—Encysted.

23. *Collotonema minutum.*—Fluid.

23* " " Dry.

This remarkable object is found in great abundance in an iron spring, forming thick skins; when fresh there is no difficulty in tracing tubular structure. The dry specimen, prepared by burning, will task the resolving powers of best objectives. I have been unable to "raise a ripple" on it; it is on sufficiently thin glass to use $\frac{1}{16}$th; burnt on the cover itself. Have found it conjugating.

24. *Stauroneis acuta*, &c.

25. *Gomphonema olivaceum.*

26. *Nitzschia linearis.*

27. *Orthosira ovichalcea.*—Formed, not only with walls, like *Melosira varians*, but with internal cells, as mentioned by Smith, S. B. D., in connexion with Mendior. This formation of internal cells, which may be observed in No. 30, and which occurs in *Fragillaria capucina*, is undoubtedly interpreted right by Mr. Ralfs, 'Microscopical Journal,' vol. vi, p. 14.

28. *Mansfield.*—Contains *P. obturatum* of Sull.

29. *Gomphonema*, n. sp.—Found conjugating; it resembles No. 2, but is smaller, and has double sporangiæ; the specimen was prepared by burning, and a little circle scratched on the cover will point out conjugating specimens. I have named it provisionally "paradoxum."

30. *Meridion constrictum.*—Developed into a straight filament. Notice the nodules alternate at top and bottom.

31. *Meridion constrictum.*—Prepared by burning.

32. *Gomphonema.*—Same as No. 2.

33. *Meridion constrictum.*—Distorted.

34. *Epithemia*, &c.
35. *Cocconema cistula*, &c.
36. *Cymbella Helvetica*, &c.
37. „ *maculata.*
38. *Fragillaria constricta.*—Prepared by burning.
39. „ „ Balsam; on boiling in acid the filament is destroyed; truly fragile.
40. *Hyalodiscus californicus.*—Simply enclosed as good test for one-fifth, and to fill box.

NOTE TO No. 7.

Within the small circle scratched on the cover will be found a very large and pretty Collotonema, as yet rare here, though abundant in gatherings made near Montreal, U. C., by my friend Dr. Wormley. I have found it in the tubes, and call it *C. Sullivantia*, in compliment to N. Sullivant, Esq., of Columbus, O. I regret that the limited time I have had to prepare these notes makes them so brief, but hope ere long to communicate more fully. I have little doubt that I have completely traced the passage from the sporangial frustule to the parent, thus completing the broken chain. Within the large sp. frustule, which lies apparently dead for awhile, like a resting spore, there forms a perfect individual, subsequently free by opening of the sp. shell; and in the three cases in which I have traced it, viz., *Coc. lanceolatum*, *Gomph. acuminatum*, and *Navicula cuspidata*, there was produced but a single frustule, just half size, from each sporangium. I am still investigating this point.

I forgot to say a beautiful Amphiprora, much larger and finer marked than the *A. paludosa* of Smith, occurs sparingly. I hope to send specimens soon. I think it is *A. ornata* of Bail.

On the Siliceous Organisms *found in the* Digestive Cavities *of the* Salpæ,* *and their relation to the* Flint Nodules *of the* Chalk Formation. By Surgeon G. C. Wallich, M.D., Retired List H.M. Indian Army.

(Read December 14th, 1859.)

However difficult may be the task of investigating successfully the phenomena peculiar to the minute animal and vegetable forms by which we are immediately surrounded on land, it is trifling in comparison with the task of conducting similar investigations at sea. The haunts of the organisms frequenting our streams, lakes, rivers, and even the shallower seas, are all fixed by something like definite boundaries, within which we may generally assure ourselves of their presence, or, if needs be, devise means for their capture. Not so, however, with the minute inhabitants of the open sea; for, there, we are at once met by a series of most perplexing obstacles to research; and, did no indirect means present themselves whereby it might be carried on, the prospect would, in all probability, be hopeless. But, fortunately, we possess, in some of the lower forms of animal life, a class of microphagic collectors, who, living in the element surcharged with the material we seek for, gather it together for their sustenance, and are, at the same time, easily captured. The Salpæ stand foremost amongst those creatures, being almost universally distributed through the open sea, and frequently occurring in such vast multitudes, as to cover the surface for many square miles, and impart to the water the consistence of a jelly. Independently, therefore, of the interest which has attached to the Salpæ, since Chamisso discovered, in their reproductive process, the remarkable phenomena to which he applied the term "Alternation of generations," they exhibit a faculty of the highest value to the microscopist; and there cannot be a doubt that, under a systematic examination of the Salpean alimentary matter, obtained from various latitudes, we should speedily be enabled to accumulate a mass of facts, not only of importance to microscopical science, but to the natural history of the sea generally.

I am somewhat desirous of laying stress on this source of

* Although the Salpæ are especially referred to in this communication, in order to avoid repetition, it is intended to embrace under this head, the whole of the molluscoid tribes that frequent the open sea in shoals, and live upon the microscopic organisms it contains.

information, inasmuch as I conceive that a large class of minute structures, and especially of Diatomaceæ, the existence of which has hitherto been unrecognised, occur in the open sea, as strictly free-floating independent organisms; and that extended inquiry will prove this class to be quite as numerous and interesting as any with which we are already familiar.

In another paper, on the Distribution and Habits of the Pelagic Diatomaceæ (a copy of which I shall have the honour of presenting to the Society in a few days), I have endeavoured to show that a vast number of these organisms are peculiar to the open sea, and that they possess a sufficient degree of buoyancy to enable them to live and move amongst its waters without the aid of any supporting body whatever. I have also pointed out the causes upon which I consider this buoyancy depends, with my reasons for assuming that the movements of which these pelagic forms are in a special degree capable, and by means of which their bathymetrical range, under different circumstances, is determined, are entirely independent of the ordinary to-and-fro motile power shared by them, in greater or lesser degree, with all other free forms of Diatomaceæ. I should not, however, refer to this paper, were I not desirous of showing the important part performed by the Salpæ in the accumulation of the deep-sea deposits; and had not certain facts presented themselves, in connexion with the Salpæ material generally, which tend to throw light on the occurrence of Xanthidia in the flints, and, if I mistake not, on the concretion of the flints themselves.

On subjecting to pressure the small nucleus seen at one extremity of a Salpa, an ochreous-coloured pulpy mass escapes. Placed under the microscope, this is found to consist of a gelatinous-looking basis, throughout which are interspersed numerous minute granules, mostly of a yellowish hue, and consisting of particles of sarcodic and endochromic substance, extracted by the Salpa from the animal or vegetable structures upon which it subsists. The larger bodies mixed up with the gelatinous basis, consist chiefly of *Diatomaceæ, Foraminifera, Polycystina, Acanthometræ,* spicules of *Thalassicolla, Dictyocha,* and minute sponges, *Xanthidia,* oil-globules, and a host of doubtful objects, to which it would be difficult to assign either a name or a position. They all bear with them, however, unmistakeable evidence of having been taken from the waters around in a living condition, the soft parts of some being still intact, both as regards substance and colour; whilst others present themselves more or less freed from their soft parts. In the case of the Diatomaceæ,

so complete is the solvent action of the Salpean stomach, that, although protected by their siliceous shell, the cell-contents are, at times, so completely removed as to give the frustules the appearance of having been subjected to boiling acids. When we take into consideration then the enormous destruction and renewal of these microscopic organisms that must constantly be going on, in order to provide food for the vast assemblages of Salpæ referred to; and, further, when we reflect that the Salpæ and other molluscoid creatures constitute in turn the almost entire source of food to the gigantic Cetaceans of the same seas, we are surely warranted in assuming that a powerful influence must be exercised on the deep-sea deposits by the exuviæ derived from these combined causes.

I shall now proceed to describe some of the most interesting forms of Diatomaceæ, alluding but cursorily to such minor forms as only deserve notice from their frequent occurrence or simple novelty; and reserving for future notice a large number of highly curious mixed forms, which it would be impossible to embrace within the limits of this paper without omitting the last portion of my subject, namely, the relation that appears to exist between the siliceous material referred to and the nodular flints of the Chalk.

COSCINODISCUS, *Ehr.*

C. Sol, n. sp.—Valvular disc surrounded by a broad membranous ring, the surface of which presents numerous radiating lines. Valve precisely as in *C. radiatus*.

Total diameter ·0016 to ·0050; diameter of central portion ·0020 to ·0025. Pl. II, figs. 1, 2.

From Salpæ, Bay of Bengal and Indian Ocean. April, 1847.

The remarkable appendage to the valvular disc at once serves to distinguish this beautiful diatom from all its allies. Indeed, at first sight, it presents us with so anomalous-looking a feature, as to render it doubtful whether it ought to be referred to the genus indicated. I shall show, however, that the membranous appendage is, after all, but a modification of structure found in other forms, and that the central disc is so identical in character with the well-known species, *C. eccentricus* as to leave no room for question.

On subjecting the frustule to acids, the membranous ring is at first simply detached; after a while it is dissolved, and the central disc then becomes indistinguishable from small valves of *C. eccentricus*. The ring is hyaline, and free from

markings, with the exception of the lines referred to. These take their rise from a row of minute marginal puncta, and, in like manner with the latter, vary in number in different specimens. Where they emerge from the disc, they present the appearance of being puckered or folded, becoming gradually linear as they approach the outer margin of the ring. In specimens preserved in their original state in fluid, both valves may be seen to possess the ring. It is evidently, therefore, an emanation from the valvular disc, and not from the connecting zones; and it may be regarded as a modification of that portion of the primordial utricle which invests the minute marginal apertures of the valve, and which, in the filamentous, stipitate, and sessile forms, assumes the nature either of an elastic cushion, a stipes, or a pedicle.

Of the highly elastic character of these extra-frustular productions we find abundant evidence in the tenacity with which the filamentous species cohere by one or both their angles, as in *Himantidium*, *Fragillaria*, and *Diatoma*; in the manner in which the long-stipitate species sustain their heavy burden, as in *Acnanthes* and *Striatella*; in the modification of the same structure observed in the highly elastic tubular sheath of *Schizonema*; in the matrix of the frondose forms, as in *Mastogloia*, *Dickieia*, and *Berkleyia*; in the nidus of all sporangial frustules or cells; and still more remarkably, as I conceive, in the delicate enveloping medium of *Bacillaria*.

On referring to the description given in the 'Synopsis of British Diatomaceæ,' vol. ii, p. 9, of the movements observed in *Bacillaria paradoxa*, the author remarks that "if the filament, while in motion, be forcibly divided, the uninjured frustules of each portion continue to move as before, proving that the filament is a compound structure, notwithstanding that its frustules move in unison." Now it is difficult to reconcile the view of a compound structure, as here conveyed, with what we know of the ordinary diatomaceous frustule, unless by admitting the presence of a highly elastic and delicate investing membrane, such as I contend for. In the usual acceptation of the term, all filamentous forms are compound; and yet, in no other diatom do we discover the very remarkable combination of movements witnessed in *B. paradoxa*.

I have tried to prove, in the paper already spoken of, that *endosmotic* and *exosmotic* action cannot possibly account either for the motions seen in *B. paradoxa*, or indeed in any other diatom with which we are acquainted; and that, in order to explain the ordinary movements, and also those very striking secondary movements exhibited by objects in the immediate

vicinity of a free-moving diatom, and which are unquestionably associated with it as cause and effect, we have no alternative but to admit the existence, although as yet undetected, of highly attenuated prehensile filaments, in virtue of which the diatom itself moves, and produces the movements we observe in surrounding particles.* The grounds upon which I rest my view are wholly based on the behaviour of the diatomaceous frustule with reference to such particles. This may probably be looked upon as assuming more than is warranted without ocular proof of the existence of the organs alluded to. I can only reply that the assumption is supported by stronger and more tangible proof than the theory of endosmotic and exosmotic action; which is, after all, nothing more than an assumption. In favour of the former view, there exists strong presumptive proof. In favour of the latter, not only is presumptive proof deficient, but such other evidence as can be brought to bear upon the question, tends at once to disprove its correctness. This I will endeavour, as briefly as possible, to demonstrate.

In general terms, endosmotic and exosmotic action may be defined as the effort whereby two fluids, of different densities, and which happen to be separated from each other by an animal or vegetable membrane, slowly commingle, and acquire the mean between their two original densities. Such an action is constantly going on in all living animal and vegetable structures, and, without doubt, in those we are more immediately discussing. The various processes of assimilation, absorption, and secretion are most powerfully influenced by it. But all I contend is, that this kind of action is *not that* whereby the peculiar movements of the Diatomaceæ are effected.

Were these organisms bicellular or multicellular, instead of being unicellular, or were the motions invariably exercised in only one given direction of the frustule, such action might possibly be taken to account for them. But there is no condition of the frustular contents which can impart the alternating character we see to the movements; unless, indeed, we admit the primordial utricle to be a bicellular structure, or that the terminal apertures of the frustule have the faculty

* The movements of particles of matter, backwards and forwards, along the edges of the frustule, are evidently produced by different organs to those which influence the movements of particles towed along at a distance from it, inasmuch as they are carried on during the progress of the diatom, and often in a direction opposite to that it is pursuing. Judging from the manner in which these marginal movements of frustules take place, it would seem probable that the organs consist of an extremely minute series of extensile tubular suckers, similar to those of the Echinidæ.

of alternately opening and closing; for either of which conditions there does not appear to exist a shadow of proof or even probability.

I would here mention having, very recently, been enabled to trace the circulation, most distinctly, in frustules of *Pleurosigma angulatum*, kindly sent me in a living state by Mr. Harrison, of Hull. The current invariably flows in one direction. At the hyaline extremity of the frustules of this species the course of the minute granules, carried round by the protoplasmic current within, was most palpable. It is precisely similar in character to the circulation in *Closterium*; the granules, however, being much smaller, and the current being uninterrupted by the presence of the terminal vesicles of the desmidiacean form. The course of the circulation, in the immediate vicinity of the terminal nodules, never varied during the change of direction of the frustule; thereby affording the most convincing proof that no alternate endosmotic and exosmotic action could be influencing its movements.

Again, if we refer to the experiment made by the author of the 'Synopsis,' to test the presence or absence of any external *ciliary* apparatus in the Diatomaceæ,* we find that the colouring particles of carmine and indigo exhibited no trace of the currents, which must have been recognisable had ciliary apparatus been in operation. And yet it does not appear to have occurred to the acute writer in question, that as such currents, no matter how produced, are easy of detection under the microscope, they ought, by a parity of reasoning, to have made themselves manifest from the action of the minute jet of fluid adduced as the result of the assumed endosmotic and exosmotic action; or, to put the case still more forcibly—it must be evident that a jet of fluid, determined by the alternate operation of endosmotic and exosmotic action, at each terminal aperture of the frustule (granting the existence of such action for argument's sake), of sufficient energy to propel it along, must of necessity have been more than sufficient to cause the dispersion of such extremely minute bodies as the particles of carmine or indigo employed. The test adduced to disprove the existence of ciliary apparatus, becomes, therefore, conclusive also against the theory it was intended to support.

In the case of elongated prehensile filaments, on the other hand, currents could not be produced. In some of the *Monadinæ*, and in *Peranema*, we may observe the kind of filament pointed to, and that it serves to propel the creature, and perform its office, without giving rise to any current

* 'Synopsis Brit. Diatom.,' vol. i, Introd., p. 23.

whatever. It is unnecessary to touch on the rhythmical alternating nature of the movements of the Diatomaceæ; we have many examples of analogous action, in both the animal and vegetable kingdoms. For, whether we examine the heart's action of one of the most highly organized animals, or the contractile vesicle seen in the animalcule, and even in some forms of the early vegetable cell, we are met by the same wondrous fact, and perplexed by the same insurmountable difficulty.

HEMIDISCUS, nov. gen., *Wall.*

Frustules free. Valve arcuate, with a marginal nodule. Cellulation hexagonal, radiate.

The valvular structure of this genus indicates a very close affinity to *Eupodiscus*, and the discoidal forms generally. Its peculiar outline, and the invariable character of the unequally developed connecting zones, distinguish it from that genus. We have examples of similar unequal development in the connecting zones of some *Surirellæ*, *Gomphonema*, *Podosphenia*, *Rhipidophora*, *Licinophora* and *Meridion*; in all of which genera the "cuneate" character of the frustule is, in a great measure, due to its occurrence.

H. cuneiformis, n. sp.—Valves arcuate, with a slight inflation and nodule at the centre of the plane margin; and a row of marginal puncta. Valve slightly convex at its margin. Cellulation distinct; hexagonal; largest at centre, from whence the cells radiate. Connecting zones broadest on the convex aspect of the frustule, the section of which is, accordingly, cuneate. Length ·0017 to ·0056. Diameter of valve ·0010 to ·0025. Pl. II, figs. 3 and 4.

From Salpæ, Bay of Bengal and Indian Ocean. April, 1857.

This species presents great variation in size. In general shape the frustule corresponds with that of the Brazil nut of commerce; the flat sides representing the valvular surfaces, and the broad convex back the broad portion of the connecting zones. Sometimes, however, the valve attains a much more arched character, and then appears almost semicircular.

I have repeatedly observed detached valves of this form in several of the guanos. As seen in these, the valves might readily be mistaken for abnormal varieties of a *Triceratium*; and it is just possible, therefore, that the *Triceratium semicirculare* of the Bermuda deposit, described and figured by Mr. Brightwell in the 'Microscopical Trans.' (vol. i, p. 256) may belong to this genus. In the figure appended to Mr. Brightwell's paper, the arrangement of the cells seems to

tally in every point, the general outline differing only as regards the central convexity of the plane margin and the absence of the nodule. The same remark applies to Ehrenberg's *Triceratium obtusum*, which is akin to Mr. Brightwell's form. (*Vide* 'Mikrogeologie,' t. 18—49.)

STIGMAPHORA, nov. gen., *Wall.*

Frustules free, naviculoid. Valves lanceolate, "loculate." Loculi with central and marginal puncta.

From the very hyaline nature of this diatom, and its occurring somewhat rarely, the precise structure of the loculated portion is perhaps doubtful. The resemblance to *Mastogloia* is apparent, rather than real, for the subjoined reasons:—The supplementary nodules, which may be observed in one species, in the course of the median line, are obviously repetitions of the ordinary terminal and central nodular processes. Now each "loculus" presents a minute nodule of precisely similar aspect at its centre. When the frustule is seen in a front view, the nodules of the median line and the loculi appear in the same plane. It is difficult, therefore, to conceive that the one set of nodules should belong to the valvular structure, whilst the other forms portion of an annular appendage. But, under any circumstances, the nodules of the loculi, and those elsewhere met with, afford a marked character whereby this genus may be distinguished.

S. rostrata, n. sp.—Valves lanceolate and suddenly contracted half-way between the centre and extremities of the valve, so as to make the latter seem rostrate. Valve slightly inflated at its central margin. Loculi in two pairs. Seen in the side view they appear like two small pyriform cells, united by their bases, and situated just within the inflation. Median line with from three to ten supplementary nodules, arranged equidistantly along the rostrate portion of the valve.

Front view, linear lanceolate, truncate at the ends; median lines being distinguishable within the valve, and parallel to its margins. Length ·0038; breadth ·0006. Figs. 5 and 6.

From Salpæ, Bay of Bengal and Indian Ocean. April, 1857.

S. lanceolata, n. sp.—Valves lanceolate, extremities acute. Loculi as in first species, but with an additional minute nodule on their inner convex margins. Median line without

supplementary nodules. Front view as in last species, with the last exception.

Var. *β*, with two minute nodules, in juxtaposition, halfway between central and terminal nodules of the median line.

Length ·0038; breadth ·0007. Figs. 7 and 8.

Habitat with the last.

ASTEROMPHALUS, *Ehr.*

The next forms to be noticed belong to the genera *Asteromphalus* and *Asterolampra* of Ehrenberg. Before describing them, however, it is necessary that I should state the grounds upon which I have ventured to revise the characters of these two genera, and to ignore the supplementary genus *Spatangidium*, more recently established by M. Brébisson. It is not without considerable hesitation that I attempt to modify the classification offered by Dr. Greville in the 'Transactions' of the Society, only a few months ago ('Trans. Microscop. Soc.,' vol. vii, p. 157). That hesitation is, nevertheless, in some degree lessened by the knowledge that Dr. Greville's views have undergone an alteration since the appearance of the paper referred to; and by the hope that the opportunities I have had of examining a very large number of recent specimens of both genera, may obtain for me some claim to be heard.

The characters of *Asteromphalus* are—"Frustules single, equally bivalve, circular; valves marked with alternate rays, forming a double star; central rays (imperfect septa) not reaching the margin, two of them parallel, the others diverging; marginal rays broader, smooth, flat, one being absent or so far obsolete, that the two central rays inclosing it become parallel;"—

Whilst in *Asterolampra* the characters are—"Free; frustules single, equally bivalve, circular; central portion imperfectly divided by thin septa, which do not reach the margin, but alternate with rays extending to the margin, unsupported by septa" ('Microg. Dict.')

M. Brébisson's sub-genus *Spatangidium* was devised in order to separate such forms as have the rays arranged excentrically from those in which they are arranged centrically, the "secondary or umbilical" rays being very properly ignored.

Dr. Greville, again, proposes to modify M. Brébisson's characters by placing, under *Asteromphalus*, such forms as have their discs "finely granulated," and a "centrical or excentrical hyaline area;" whilst *Spatangidium* includes the forms

with "distinctly areolated discs" and "an excentrical hyaline area."

The confusion into which these genera have fallen appears to have arisen from the fundamental error of viewing the *sutures* of the basal portion of the true rays as "secondary or umbilical rays." Omitting, for a moment, the question as to the true nature of the "septa," or "imperfect partitions," spoken of by Ehrenberg, and assigned by him both to *Asteromphalus* and *Asterolampra*, a marked character exists by which alone these two genera may be distinguished from each other. It consists in the presence, in the first-named genus, of that ray variously designated as the "median," "nuclear," and "obsolete" ray; and for which I propose to substitute the name *basal ray*, from the true rays being always arranged around or upon it. But in addition to this primary character it will be found, on looking at the front view of frustules of the two genera, that an important generic character may be derived from the internal structure of the valves; "the imperfect partitions" being seen to dip down towards the interior of the frustule of *Asteromphalus*, whilst they do not occur, at all, in *Asterolampra*, save as linear markings similar to those seen on the external surface.

Simple repetition of parts, such as the rays of these genera, and trifling modifications in outline, must be looked upon as insufficient bases for specific distinction. In like manner the centrical or excentrical arrangement of the rays is a character on which no reliance can be placed, as both may be seen to occur in different individuals indubitably belonging to the same species. As a general rule, a certain degree of excentricity must exist, as the natural result of the presence of a basal ray. Nor could it well be otherwise, when we reflect that the diatomaceous frustule, once formed, admits of no change of structure, and that the excentricity is therefore the result, and not the cause, of the peculiarity in the basal ray. That some definite function is performed by the rays must be inferred from the fact that, in numerous specimens preserved in balsam, some of the rays may be seen filled with an air-bubble, proving that they are tubular. But so long as the true and basal rays do not deviate in structure from their normal types, mere number, and the simple *amount* of excentric arrangement, may safely be regarded as depending on causes not of a constant character.* The rays,

* In the October number of the 'Quarterly Journal of Micros. Science,' Mr. Roper, whilst commenting upon Mr. Johnston's paper, draws attention to the fact of Mr. Shadbolt having pointed out, some years ago, the "alternate disposition" of the valves in *Asterolampra*. The same structure has

both in *Asteromphalus* and in *Asterolampra*, are formed upon the same general plan. They consist of an expanded base, by the margins of which they are united together, or to the *basal ray;* and of the free hyaline arm which is directed towards the circumference of the valve. The curvature occasionally seen in the last-named portion of the rays is extremely variable in extent. The connecting *sutures*, on the other hand, afford a tolerably constant character, and are important, inasmuch as on the shape of the connected portions of the rays depends their contour. The basal rays also yield good characters, their capitate extremities being either wholly or partially overlapped by the true rays, and being either angular, clavate, emarginate, or simply elongated.

ASTEROMPHALUS, *Ehr.*

Frustules free; disciform. Valves orbicular, sub-orbicular, or oblong, with an indefinite number of hyaline rays arranged round the capitate extremity, or one or more basal rays. Front view of frustule exhibiting "imperfect septa." Cellulation of inter-radial spaces hexagonal.

Section I.—Basal ray single.

A. imbricatus, n. sp.—Rays numerous, arranged more or less excentrically round the clavate elongated extremity of the basal ray; one ray opposite to and continuous with the basal ray. Sutures angular.

Var. β. Sutures plane.

Var. γ. Capitate extremity of basal ray emarginate.

This remarkably beautiful disc presents us with one extreme of the series, of which *A. sarcophagus*, a species immediately to be noticed, constitutes the other. The basal ray being directed towards the observer, the true rays on either side, gradually diminish in size till they reach the *odd* ray, which is only about half the size of the largest one. The arrangement is thus rendered very excentrical. Extremity of basal ray much produced. Cellulation conspicuous. Diameter of valve ·0029. Fig. 9.

From Salpæ, Bay of Bengal. April, 1857.

A. elegans, Grev.—This form represents a variety of Dr.

also been noticed, in a few species, by other observers since Mr. Shadbolt's discovery. It will be found, however, I believe, in most discoid forms, although only observable in those that have conspicuous markings and hyaline valves. It certainly occurs in *Eupodiscus*, *Asterolampra*, *Campylodiscus*, and in the sigmoidally bent form of *Biddulphia turgida*. In the last two, the valves are placed at right angles to each other.

Greville's; the capitate extremity of basal ray being laterally emarginate, central suture plane, others angular. Diameter ·0021. Fig. 10.

From Salpæ, Indian Ocean.

A. malleus, n. sp.—Rays linear, in two or more pairs, arranged on each side of the malleiform extremity of the basal ray. Upper (*i. e.* inner) edge of basal ray free. Cellulation very conspicuous. Sutures plane. Diameter ·0021. Fig. 11.

From Salpæ, Indian Ocean. May, 1857.

A. sarcophagus, n. sp.—Valve oblong, with a slight constriction near each extremity. Basal ray plane, and continuous with one of the true rays. Sutures plane. Cellules very large.

The broadest portion of this species is always towards the extremity opposite the basal ray, thus giving the valve a somewhat pyriform or sarcophagus-like shape. Length ·0018; breadth ·0009. Fig. 12.

Indian Ocean. From Salpæ. May, 1857.

Section II.—More than one basal ray.

A. Grevillii.—Basal rays three in number, united at the centre of valve by their capitate bases, and forming a Y-shaped figure. The remaining (eight) rays having cuneate bases, which are arranged between the angles formed by the decussation of the basal rays. Sutures of true rays plane.

The free portions of both sets of rays are of the same size, and suddenly expand, giving a circular aspect to the central part of the disc. Diameter ·0025. Fig. 15.

Indian Ocean. May, 1857.

I beg to associate this beautiful diatom with the name of one of our oldest and most acute microscopic observers.

ASTEROLAMPRA, *Ehr.*

Frustules free; disciform. Valves orbicular or suborbicular, with an indefinite number of hyaline rays, which are united together by their angular bases. Basal ray absent. Cellulation of inter-radial spaces hexagonal. Free margin of rays granulated.

A. Marylandica, Ehr.—The only species noticed by Kutzing is the fossil one described under the above name by Ehrenberg, the number of rays being restricted to eight. Specimens in my possession exhibit six, seven, and twelve rays, without the slightest structural difference. Figs. 13 and 14 are appended in order to show the wide range of form

assumed by the rays in these diatoms; the rays in the first being almost rhomboidal, whilst those in the second are almost linear. The figures clearly prove that the so-called "umbilical rays" are merely the sutures of the bases of the rays.

Fig. 13, var. β. Diameter ·0015.

Fig. 14, var. γ. Diameter ·0019.

Bay of Bengal, Indian Ocean. From Salpæ.

Chætoceros bacteriastrium, n. sp.— Filament cylindrical. Valves more or less cup-shaped, discoidal. With from four to twelve marginal awns.

The valves in this species resemble Mr. Shadbolt's genus *Bacteriastrium* so closely, as to leave no doubt of both belonging to the same form. The varieties are very numerous, but differ only in number of awns, and their simple or furcate character. Size extremely variable.

Very frequent and abundant.

Atlantic. From Salpæ. Figs. 16 and 17.

Chætoceros boreale, Bailey.—This form is figured in order to show the cup-shaped structure of the valves, and the cylindrical connecting zones.

Very frequent.

Atlantic. From Salpæ. Fig. 18.

Triceratium punctatum, n. sp.—Valve with a minute horn at each angle, and a line of marginal puncta. Cellulation minute, radiating from centre. Diameter ·0012 to ·0015. Fig. 21.

Bay of Bengal, Indian Ocean, Atlantic. From Salpæ.

Frequent.

Coscinodiscus radiatus, Ehr.—A small variety, with a crenate border within the margin. Diameter ·0010. Fig. 22.

Bay of Bengal, Indian Ocean. From Salpæ.

Synedra doliolus, n. sp.—Frustules linear, frequently forming a cask-shaped group, by their adherence after division. Valve sub-arcuate. Pseudo-nodule absent. Striæ 30 in ·001. Length ·0020 to ·0050.

Bay of Bengal, Indian Ocean, Atlantic. From Salpæ.

Common. Fig. 19.

This form is unquestionably a free species, and may be placed under Synedra provisionally.

Nitzschia lanceolata, Sm.—A variety with the striæ arranged in quincunx, what under certain aspects gives the appearance of oblique striation. Length ·0060 to ·0075. Striæ 48 in ·001.

Bay of Bengal, Indian Ocean, Atlantic. From Salpæ.

Frequent. Fig. 20.

The history of the fossil *Xanthidia* of the Cretaceous flint nodules has hitherto been beset with a most perplexing difficulty. Apart from the much-vexed question as to the manner in which the siliceous element of the nodules became aggregated into masses, so as to enshroud these structures, the occurrence of organisms, held to be strictly inhabitants of fresh water, in deposits of unquestionable marine formation, presented an ample field for discussion and conjecture. The Desmidiaceæ, of which family the Xanthidia constitute the sporangia, are thus described by Mr. Ralfs: "All the family are inhabitants of fresh water. Mr. Thwaites, indeed, has gathered two or three species in water slightly brackish, but the same species are also found in localities remote from the sea. Certain marine objects that have been classed with the Desmidieæ have the internal matter of a brown colour, but these belong to the Diatomaceæ."*

In order, therefore, to account for their occurrence amongst purely marine deposits, it was deemed necessary to assume that they had been washed down by rivers or floods, or transported by winds from the land to the sea; where, after gradually subsiding, they became incorporated with the siliceous material in which they were found imbedded. The tough, semi-horny texture of their outer covering, and well-known power of withstanding extreme climatic changes, seemed to favour this idea of their indestructibility, even under conditions so opposed to those in which they originally lived. But the explanation was, at best, unsatisfactory.

The discovery of two well-marked varieties of Xanthidia, in a recent state, amongst the alimentary contents of the *Salpæ*, was, therefore, fraught with no slight interest. From the condition of their endochrome it is certain they had but recently been inclosed in the cavities of these creatures; and from the situation in which they were discovered, it is equally certain that they could not have been derived from fresh-water sources by any of the agencies above referred to. But whether or not these bodies are the sporangia of genuine pelagic *Desmidiaceæ*, they certainly exhibit an identity of appearance and structure with the fossil forms, too striking to admit of question. The probability, however, of their being true pelagic representatives of this family is greatly enhanced by the occurrence, in the same material, of bodies closely resembling the *Closteria*. These have only been met with sparingly, and it has been impossible, therefore, to determine their nature with certainty. But the strongest evidence in favour of their identity with the fossil *Xanthidia* is derived from

* Ralfs' 'British Desmidieæ.' Introd. p 2.

their association, in the recent state, with other organisms, such as *Diatomaceæ*, *Foraminifera*, and *Acanthometræ*, whose fossil remains, in like manner, occur associated with them in the flints. The question as to their being true sporangia of *Desmidiaceæ* becomes, therefore, of secondary importance.

On endeavouring to identify, if possible, the *Xanthidia* of the Salpæ material with some of the described fossil forms, I was struck by the marked resemblance the first species, figured by Mr. H. H. White (in the 'Trans. Micros. Soc., for 1847, vol. i, p. 77), bore, *not* to my *Xanthidia*, but to *Coscinodiscus Sol.* The central portion, as rendered in the figure, certainly exhibited no trace of hexagonal cellulation, such as is to be found in all the *Coscinodisci*. But the peculiar membranous expansion, and its ragged border, tallied in so precise a manner with certain specimens of *C. Sol* that had become partially dried, by accident, on the slides containing them, that, on turning to the letter-press, it was with no small pleasure the following passages struck my eye.

"*X. vestitum*, so named from the *transparent membrane* which extends beyond the body" and again, "It has the appearance rather of a superficies or disc, than of a solid body."

All doubt on the question has been set at rest, however, inasmuch as, through the politeness of Mr. White, I have had an opportunity of inspecting the identical specimen from which the figure referred to was drawn; and, not only has my examination confirmed the first impression, but lent strong additional testimony in its favour, the membranous expansion of the fossil specimen proving to be unquestionably double, as is the case with the recent one.

In sections of flint in my possession, the remains of the obliquely truncate cylinders of *Rhizoselenia* and spicula of of *Acanthometræ* may be distinctly recognised. Both these forms are also plentifully found, in a recent state, in the Salpæ stomachs. But, as in the case of the fossil disc in Mr. White's collection, all trace of markings on the siliceous envelopes are lost. The soft contents have retained the original outline, and the geometrically arranged spicula of *Acanthometra* are represented by the dark metamorphosed granules of sarcode, which, in the living condition of the organism, had occupied its tubular cavities and nucleus.

In the recent state the siliceous organisms had been associated with the *Xanthidia*. In the fossil state, they still were found together. But whence had vanished the beautiful and very conspicuous network of the disc? It had yielded

to the same sequence of disintegration and reconstruction that had been undergone by every siliceous particle constituting the nodule which enveloped it. And imperishable though the material, both in its former and present state, all trace of its exquisite structure had been obliterated; whilst the delicate fabric it once served to support alone remained to tell the wondrous history.

I have alluded in a previous part of this paper to the food of the Salpæ and other pelagic creatures being composed, in a great measure, of Diatomaceæ and other siliceous-walled organisms. I have pointed out in what inconceivably vast multitudes the Salpæ are met with; and endeavoured to establish some relation between the siliceous exuviæ of these creatures, and, on a yet vaster scale, the exuviæ of the gigantic cetaceans that feed, in turn, upon the Salpæ, with the siliceous material to be found in the deep-sea deposits.

But another most important and interesting point demands notice. Namely, *the extent to which, by these combined operations, the siliceous particles may become accumulated into masses, either by chemical combination or simple elective affinity, so as to account for the layers and nodules of flint which occur in the Chalk formation.*

Few subjects, probably, have given rise to greater difference of opinion and discussion than the flints in question. Professor Ehrenberg has stated an opinion that the flint nodules and layers of the British Chalk formation have been derived by some metamorphic process from strata of Diatomaceæ, which have disappeared under its action.

Again, it is believed by some eminent geologists that flints are aggregations of silex, round some organic nucleus, such as sponges, pieces of coral, shell, and the like; and that such aggregation took place whilst the silex was held in a state of solution by the waters of the deposit. But this view can hardly be said to account, in a satisfactory manner, for the segregation of the siliceous compound into distinct masses and layers, such as are to be found in the Chalk formation, and which impart to it a degree of stratification.

Others regard the action as one of molecular affinity. "There appears no evidence," says Mr. Brande, "of its (*the Chalk*) having been precipitated from chemical solution; but, on the other hand, it bears marks of a mechanical deposit, as if from water loaded with it in a state of fine division. And upon this principle, some gleam of light may perhaps be thrown upon the enigmatical appearance of the flints; for it is found that if finely powdered silica be mixed with other

earthy bodies, and the whole diffused through water, the grains of silica have, under certain circumstances, a tendency to aggregate into small nodules; and in chalk some grains of quartz (fragments of siliceous spiculæ, &c.) are discoverable."

This theory, no doubt, is perfectly correct as far as it goes; and the agency described does, in all probability, perform a part in the segregative disposition of the flint formation. But, when it is taken into consideration that a state of undeviating repose is maintained in the depths at the bed of the ocean, and that the calcareous particles, which go to form the Chalk, are deposited in a pulpy mass, presenting a homogeneous surface upon which any foreign deposit would be equably distributed, it is clear that other agencies must also be at work in order to produce the results observed. Under such a state of repose, were the tendency of the minutely divided particles of silex to aggregate together the sole agency in the flint formation, we should find the concretions obeying some general law as to size, shape, structure, and position. But no such connexion can be traced. The masses are distributed in layers, and these do not present themselves equally throughout the Chalk formation. I am aware it has been asserted that the siliceous beds of Diatomaceæ of the South of Europe and the North of Africa are of later formation than the Chalk. But the Chalk itself yields sufficient evidence of the presence of diatomaceous and other minute siliceous organisms in the waters of that period. The occurrence in a fossil state in the Chalk, and, as I have shown, *in the flint itself*, of forms living at the present time, indicates that the sea abounded with the same kind of siliceous organisms in those times as in the present. And, on the other hand, there is no evidence to prove that the waters of the Cretaceous period were more profusely charged with silex in a state of solution than the waters of the existing seas. So that the simple molecular affinity of the siliceous particles for each other, although operating "under certain circumstances," cannot be accepted as the principal agency by means of which they have been aggregated together, through vast undisturbed spaces, in the irregular manner in which they are discovered in the Chalk formation.

In the guanos, although on a very limited scale, this aggregative tendency may be detected. In this kind of deposit masses may often be found composed wholly of cohering frustules of Diatomaceæ. The Rhizoseleniæ occur thus impacted together, forming small bundles, and possessing considerable cohesive force. It is worthy of notice that these

are the forms which were observed by me in the Bay of Bengal and Indian Ocean, floating near the surface in calm weather, in flocculent masses, from one to three inches long;* and that, although not seen floating in the same condition on the Atlantic side of Africa, I have repeatedly taken numbers of the larger Salpæ, of six or seven inches in length, whose digestive sacs contained hardly any thing else. When swallowed by sea-birds, and freed from the nutritive material supplied by the bodies of the Salpæ, these masses would naturally cohere in the manner described; and it is highly probable, moreover, that the coherent tendency would be much increased by the partial conversion of a portion into soluble hydrates or silicates, the cementing property of which compounds is well known.

This cohesive quality has been noticed also by the late Professor Bailey, of New York, as occurring in several diatomaceous deposits, but especially in that of California. Professor Bailey observes, "Some of these masses I endeavoured to break up by boiling in water and in acids, and also by repeated freezing and thawing when moistened, but without good results in either case. At last it occurred to me that the adherence might be due to a slight portion of a siliceous cement, which the cautious use of an alkaline solution might remove without destroying any but the most minute shell of the diatoms. As the case appeared a desperate one, a heroic remedy was applied, which was to boil small lumps of the diatomaceous mass in a strong solution of caustic potass or soda. This proved to be perfectly efficacious, as the masses under this treatment rapidly split up along the planes of lamination, and then crumbled to mud." †

Now bearing in recollection this primary tendency of siliceous particles to cohere, let me review for a moment the conditions that present themselves to our notice.

We find that the siliceous particles of the *Diatomaceæ*, *Polycystina*, *Acanthometræ*, and *Sponges* exist not only in a state of the utmost purity, but that they occur precisely in that state of minute subdivision which favours the solvent or aggregative process in an eminent degree. We see that they are gathered together by the Salpæ, in the first instance, from the element in which they live, and that they are freed of all, or nearly all, their soft portions, by the action of the digestive cavities of these creatures. We find that the

* 'Trans. Micros. Soc.,' vol. vi, p. 84.

† 'American Journal of Arts and Sciences,' 2d Series, vol. xxi, May, 1856.

Salpæ again, in inconceivably vast numbers, afford almost the entire food of the largest orders of cetaceans; and I therefore think we are able to infer, with certainty, that, in the complex stomachs and intestines of the latter, the further process of aggregation of siliceous particles goes on upon a gigantic scale, aided by the presence of the alkalies, and that the aggregated masses being voided at intervals, slowly subside, without disruption, to the bed of the ocean.

It must also be borne in mind that the whales are gregarious animals, frequenting particular latitudes at particular seasons, and migrating under certain circumstances; and that to the operation of these causes the irregular character of any exuvial deposits might naturally be referred. And lastly, that it is by no means essential that chemical forces should operate upon the siliceous aggregations, whilst yet within the intestinal canal of the cetaceans, to such an extent as to render their concretion at all complete. But there can be no difficulty in conceiving that during the passage of such aggregations through their cavities a sufficient degree of chemical action might take place to ensure their continuance in the aggregated state until they reach the pulpy cretaceous stratum destined to be their final resting-place; whilst amidst the undisturbed quietude of those depths each fragment of the numberless forms of organic life, with which the seas of the secondary epoch teemed, would naturally become a nucleus, around which the still plastic siliceous material might slowly gather and consolidate.

The coprolites, derived from another series of oceanic monsters that frequented the seas of the same epoch, furnish us with an analogy, in so far as the deposition of animal exuviæ in masses and at great depths is concerned. But in this case the nature of the exuviæ left little to be done, either by chemical or mechanical action, after their extrusion.

None of the theories hitherto offered have indicated, in a satisfactory manner, any means whereby the siliceous elements could reach the sea-bed in already aggregated masses. It is essential, I conceive, that a certain amount of aggregation should take place in those masses before arrival at this stage of their history. For, as already stated, had the cohesive tendency of the siliceous particles alone determined the character of their formation, the nodular concretions must of necessity have been found arranged in obedience to some definite law, both as regards distribution and structure.

The theory now offered is by no means intended to supersede others, but only to be auxiliary to them, by pointing out an agency through which the widely scattered siliceous parti-

cles of the ocean may be accumulated together into masses and rendered sufficiently coherent to admit of their reaching the sea-bottom without absolute disruption.

Xanthidium.

X. —— ?—Cell sub-spherical, with from eight to ten long tapering spines, the extremities of which are dichotomously divided. Endochrome (as taken from the Salpæ stomachs) of a pale yellowish-green colour, generally shrunk to a slight extent. Cell-wall exhibiting the primordial utricle and a stout horny external (cellulose) layer continuous with the spines. Diameter of cell ·0012; total diameter ·0038. (Fig. 23.)

Bay of Bengal and Indian Ocean. April, 1857. From Salpæ.

Fig. 24 represents *X. vestitum*, as copied from Mr. White's figure.

Fig. 2 represents a frequent form of *C. Sol*, in which the proportion between the size of the disc and membranous ring approaches very closely to that seen in the fossil.

On Triceratium Arcticum. By F. C. S. Roper, F.L.S., &c.

The genus Triceratium was first proposed by Professor Ehrenberg, in a paper read before the Berlin Academy in 1839, to include a class of forms which he stated to be free or non-concatenate.

Well known as the large and peculiar species of this genus have been, from that time to the present, to those who have studied this class of algæ, it is a remarkable fact, that all the well-known species, such as *Triceratium favus, alternans, striolatum*, &c., which occur in the tidal harbours and estuaries of our coasts, have been met with merely as scattered specimens in the mud, and never in a living state, or attached to larger algæ, as is frequently the case in the genera Biddulphia, Amphititres, and Isthmia.

Relying on this negative evidence, all writers on Diatomaceæ have followed the German Professor in describing the genus as non-concatenate, and in the synopsis of Professor

Smith we find it included amongst the free forms of his first sub-tribe, though differing widely in general structure from all the other genera included in it.

The only statement that has been published, tending to throw light on the mode of growth of the larger species of Triceratium, is in the introduction to Mr. Brightwell's valuable synopsis of the genus, published in 1853, in 'Micr. Jour.,' vol. i, p. 246, where, in alluding to a species named by him "*Arcticum*" (from its having been brought home by Dr. Sutherland from Beechy Island, in the Arctic seas), he says, "The frustules of this species were found in a mass, unmixed with any other species of Diatomaceæ; many of the perfect frustules have the endochrome in them, and when examined as first received, had very much the appearance of being attached to a small alga found with them." Professor Smith had evidently entertained the idea that this might generally be the case; as in the 'Synopsis,' vol. i, which appeared before Mr. Brightwell's paper was published, he says, "The frustules are probably at first attached to larger algæ, but I have been unable to determine this point, from the isolated specimens which have fallen under my notice."*

Since Mr. Brightwell's paper, no further advance has been made in our knowledge of the mode of growth of the well-determined species of Triceratium, though the same author, in describing some gatherings made by Colonel Baddeley, has figured two peculiar forms under the names of *T. undulatum* and *T. malleus*, which were found in a living state and in filaments.† It will, however, require a more extended examination of the structure and habits of this group, before they can be decidedly admitted into the present genus.

The general structure of the valves in Triceratium, the horn-like processes at the angles, the frequent occurrence of spines on the surface, and the strongly siliceous and frequently reticulated connecting membrane, are so similar to that in Biddulphia, that I had long entertained the opinion that they were closely allied to that genus; and any one referring to the figures of the perfect frustules given by Mr. Brightwell in his 'Synopsis' of the genus, especially in 'Mic. Jour.,' vol. i, t. iv, fig. 5 *a*, and 'Mic. Jour.,' vol. iv, t. xvii, fig. 11 *b* and fig. 9 *b*, or who has examined with a moderate power those of *T. striolatum* in the Thames mud, will see at once how closely they approximate on the F.V. to the frustules of Biddulphia.

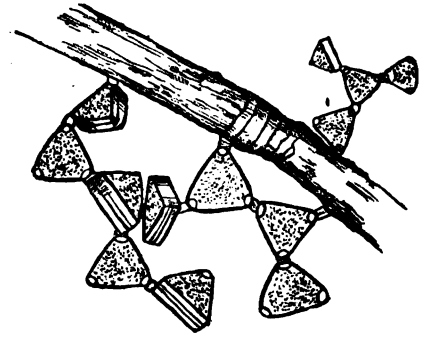
From a careful consideration of these structural peculiarities,

* 'Smith's Syn.,' vol. i, p. 26.
† 'Mic. Jour.,' vol. vi. p. 153.

(although in the absence of any direct proof), I stated in a paper read before this Society last year, that Triceratium, in any good natural arrangement of the genera, ought to be placed as intermediate between Amphitetras and Biddulphia*—in fact, the more extended knowledge we now have of the curious four-sided frustules that occasionally occur, of which four have been recorded as established varieties of *T. favus, armatum, formosum,* and *Arcticum,* would tend to show a very close affinity to the former genus.

The object of the present communication is, to show that Triceratium has always been erroneously, considered a free form.

Through the kindness of Dr. Walker-Arnott and Professor Busk, I have had lately placed in my hands some small fragments of a *Laomedea* from Vancouver's Island, with numerous specimens of a Triceratium attached to it, and the frustules are clearly united by their angles into a zigzag filament, as in the annexed figure, by a short thick gelatinous cushion or stepis, exactly as occurs in Amphitetras. In some few cases I have found frustules subdividing, and the persistence of the connecting membrane as in Biddulphia, is another most important fact to be taken into consideration in locating the genus in any natural arrangement of the class; and shows, I consider, that there can be now little, if any, hesitation in removing it from Professor Smith's first sub-tribe, and placing with its natural allies in his fourth.



TRICERATIUM ARCTICUM, × 45.
VANCOUVER'S ISLAND.

With respect to the species to which these frustules can be referred, there appears to be some little confusion, which it would be well to clear up. Mr. Brightwell, in a paper dated June, 1853, has described a species under the name of *Triceratium Arcticum*†, but appears to have made some error in the measurement, as, though stated to be only $\frac{1}{250}$th of an inch in diameter, the valves which he kindly sent to me have distinct, though small, reticulations, and the diameter is $\frac{1}{120}$th

* 'Mic. Jour.,' vol. vii, Trans. M. Soc., p. 21.
† 'Mic. Jour.,' vol. i. p. 250, and t. iv, fig. 11 *a* and *b*.

of an inch: his figures and description are, however, sufficient to identify the species.

In October, 1853, Professors W. H. Harvey and J. W. Bailey, in describing some species of Diatomaceæ adhering to or entangled in algæ, brought home by the United States' Exploring Expedition under Captain Wilkes, U.S.N., have described a species as *Triceratium Wilkesii*, from Puget's Sound,* and also a form under the name of *Amphitetras Wilkesii*, which has been found with most of the known gatherings of the Triceratium, and is now generally considered a four-sided variety of the same species.

I am not aware that any of the original gathering of this species has been sent to this country; but Dr. Arnott informs me that some logs of wood were imported into Liverpool some little time back from Puget's Sound, attached to which were some zostera leaves and small zoophytes, and from a boiling made of them were obtained both triangular and square forms, which agree with the descriptions given by Prof. Harvey and Bailey, and show that these species are clearly identical with that previously described by Mr. Brightwell as *T. Arcticum*.

It follows from this, that the *Triceratium Wilkesii* and *Amphitetras Wilkesii* of Harvey and Bailey must be cancelled altogether, and the name of *Arcticum* be retained, to include the species from both localities on the ground of priority. The species from Vancouver's Island is identical in structure with the preceding forms, and though the figures given by Mr. Brightwell in 'Mic. Jour.,' vol. i, t. iv, fig. 11 *a* and *b*, are sufficiently characteristic, I give rather a fuller specific character to assist identification for the future.

Triceratium Arcticum, Brightwell.

Valves, with slightly convex or straight sides, with small but distinct areolations, radiating in lines from the centre, and becoming very minute at the angles, which are obtusely rounded, and slightly enlarged; connecting membrane with similar reticulations to the valve, arranged in transverse lines. Diam. ·0105 to ·0054 of an inch. Syn. *Tri. Wilkesii* H and B.

Var. β. Four angles. Syn. *Amphitetras Wilkesii*, H and B.

Marine, Beechey Island, Arctic Regions; Puget's Sound; Vancouver's Island; and in a fossil state at Monterey Bay.

Triceratium Montereyii, though somewhat similar in structure to *Arcticum*, is readily distinguished, from having an elevation or boss on the centre of the valve.

T. condecorum differs in the absence of the minute reticulations at the angles, and *T. striolatum* from the angles being produced into horn-like processes.

* 'Mic. Jour.,' vol. iii, p. 94.

TRANSACTIONS.

List of DIATOMACEÆ *occurring in the neighbourhood of Hull.*

By GEORGE NORMAN, Esq., Hull.

(Communicated by Dr. Lankester. Read January 11th, 1860.)

FOLLOWING the example set by Mr. Comber, in his excellent "List of Diatomaceæ, of the neighbourhood of Liverpool" (Transactions of the Historic Society of Lancashire and Cheshire.—Vol. xi.), I have, in the following Paper, attempted to give as complete a list as possible of the Diatomaceæ of Hull and neighbourhood.

In so doing, I have not been so much influenced by the desire to make the paper of so much interest to Diatomists in general, as to compile a list which will be found serviceable to those who may wish to study and collect the forms occurring in this particular locality. Apart from this, however, the list may have its use (as far as it goes) in being a record of the local distributions of these beautiful forms.

On referring to Mr. Comber's list, it will be seen, that Liverpool and neighbourhood furnishes 257 species—a large number certainly, but falling considerably below the number detected in this locality. This may be partly owing to the area included in my list, being somewhat larger than the limit taken by Mr. Comber; nevertheless, I may fairly say, that the neighbourhood of Hull is peculiarly rich in Diatomaceæ; furnishing, as it does, nearly 400 species.

It may be here remarked, that (with the exception of one haul off Flambro' Head) dredgings on our coast are untried. Sand gatherings which have yielding Dr. Donkin and others so many novelties have also been scarcely tried—These two methods, if properly carried out, would in all probability considerably increase the number of species.

It is also very likely that I have overlooked many forms which would otherwise have been recorded, had the time of

observation extended over a longer period of time. The following species were collected by myself (with the few exceptions I have mentioned) within the short period of little more than three years.

It may perhaps be objected to, that species have been included which strictly speaking have not occurred in this neighbourhood. I allude here to the various forms collected from Ascidians taken from Oysters, dredged some 30 miles from the Humber mouth; but when I state that these Ascidians may always be found on Oysters in the Hull market during the winter months, I think the objection is overruled. Again, I have thought proper to include one or two species collected in the Docks from the bottoms of vessels recently arrived from abroad. In so doing, my object has been to point out this source for many interesting forms, and to stimulate others to examine vessels arriving in our various shipping ports. *Diatoma hyalinum* and *Hyalosira delicatula* have occurred to me copiously in such localities.

I have already stated, that—with few exceptions—the species enumerated in the following list have been collected and identified by myself, consequently I alone am responsible for the correctness of the same.

The exceptions are the species and localities furnished by Mr. Robt. Harrison, and Dr. Munroe, to whom my best thanks are due.

It will be seen that I have included the Genera *Rhizosolenia, Dicladia, Chætoceras, Syndendrium,* and *Bacteriastrum,* which may or may not with propriety be considered as true Diatomaceæ. They are however, in my opinion, so closely allied that I have not hesitated to admit them.

EPITHEMIA, Kützing.

E. turgida, Sm.—Not uncommon. Risby Pond. Peat Deposit, Hornsea. Plentiful in a pond, Stepney Lane.

E. Westermanii, Sm.—Rare. North Humber Bank, Dr. Munroe.

E. Hyndmanii, Sm.—Rare. Peat Deposit, Hornsea.

E. granulata, Kütz.—Rare. Hornsea Mere. Hornsea Deposit.

E. Zebra, Kütz.—Not uncommon. Hornsea Meer. Driffield. River Hull, Wawne.

E. Argus, Sm.—Rare. Hornsea Deposit.

E. alpestris, Sm.—Rare. Hornsea Deposit.

E. proboscidea, Kütz.—Local. Tetney Lock. Hornsea Deposit.

E. Sorex, Kütz.—Rare. Pond in Stepney Lane, copious.

E. Musculus, Kütz.—Not uncommon. Brackish marsh, Tetney Lock. Timber Pond, Victoria Dock. Ditch near Stoneferry.

E. constricta, Sm.—Rare. Brackish marsh, Tetney Lock. Brackish Ditch near Stoneferry. North Humber Bank, Dr. Munroe.

E. gibba, Kütz.—Not unfrequent. Risby Pond. Driffield. Brackish pond near Tetney.

E. ventricosa, Kütz.—Not uncommon. Risby Pond. Brackish marsh, Tetney Lock. Salt-water Ditch, Stallingbro'. River Hull, Wawne. Hornsea Peat.

E. marina, Donk.—Rare. Sands, Hornsea.

CYMBELLA, Agardh.

C. Ehrenbergii, Kütz. — Not uncommon in fresh water. Hornsea Peat. Cottingham. Spring Ditch.

C. cuspidata, Kütz.—Not uncommon, but never abundant. Saltersgate. Harrogate. Frequent in gatherings, Cottingham.

C. affinis, Kütz.—Local. Abundant in a gathering near Harrogate.

C. maculata, Kütz.—Frequent. Pure, in a ditch running from Anlaby to Hessle Road. Beverley. Cottingham. Haltenprice. Reservoir Waterworks.

C. Helvetica, Kütz.—Rare. Rocky stream, Saltersgate. Spring Ditch. Market Weighton Canal.

C. Scotica, Sm.—Rare. Rocky stream, Saltersgate. Ditch, Cottingham Road.

C. ventricosa, Kütz.—Not uncommon. Pond, Skirlaugh. Inglemire Lane, near Cottingham, pure. Benningholme.

AMPHORA, Ehrenberg.

A. ovalis, Kütz.—Common in almost every fresh-water gathering; more rarely in brackish water.

A. affinis, Kütz.—Not unfrequent in brackish water. Ditch near Stoneferry. Humber Bank. Tetney.

A. hyalina, Kütz.—Frequent. Humber. Pure in a salt-water pool, Grimsby.

A. salina, Sm.—Not unfrequent. Victoria Dock Timber Pond. River Hull, near Stoneferry.

A. tenera, Sm.—Common in salt-water Pools and Ditches. Dairycoates under Railway arch. North Humber Bank, pure. River Hull, near Stoneferry.

A. costata, Sm.—Rare. Behind the Garrison, Dr. Munroe.

A. minutissima, Sm.—Fresh water. Cottingham. Beverley Parks, near Woodmancy. Springs, Newbald.

A. n. s. with capitate extremities. Growing on wall in a Fern and Orchid stove.
A. quadrata, Greg.—Rare. Ascidian gatherings.
A. arenaria, Donk.—Rare. Sands, Hornsea.
A. littoralis, Donk.—Rare. Sands, Hornsea.
A. crassa. Greg,—Rare. In Ascidians.

COCCONEIS, Ehrenberg.

C. Pediculus, Ehr.—Very common in most fresh-water gatherings. Pure, Cottingham Beck, on *Cladophora* Waterworks reservoir. Beverley. River Hull. Cottingham, &c.
C. Placentula, Ehr.—Very frequent. Cottingham. Haltenprice. Wawne. Pure on *Cladophora,* Harrogate. Waterworks reservoir.
C. Thwaitesii, Sm.—Rare. Ditch, Cottingham-road. Springs, Newbald.
C. Scutellum, Ehr.—Common on *Cladophora rupestris.* Filey. Flambro' Head. Stomachs of Ascidians.
C. diaphana, Sm.—Rare. Hornsea Deposit. Brackish ditch, Marsh Chapel.

COSCINODISCUS, Ehrenberg.

C. minor, Ehr.—Rare. Ascidians.
C. minor, Kütz.—Rare. In a slide from the Humber gathered by Dr. Redfern in 1853, and sent to me by Professor Arnott.
C. radiatus, Ehr.—Common in Ascidian gatherings. Dredgings off Flambro' Head. Rare in Market Weighton Canal. Rare in Reservoir Waterworks, where the salt water unfortunately sometimes has access.
C. eccentricus, Ehr.—Very common in Ascidian gatherings, often very pure.
C. Concinnus, Sm.—Frequent in Ascidians, sometimes very large.
C. perforatus, Ehr.?—Ascidians. Very rare.
C. ovalis, Roper.—Very rare in Ascidian gatherings.
C. Normani, Greg.—Frequent in Ascidian gatherings.
C. Labyrinthus, Roper.—Very rare in Ascidian gatherings.
C. centralis, Ehr.—Frequent in Ascidians.

EUPODISCUS, Ehrenberg.

E. Argus, Ehr.—Not unfrequent in Ascidians. Dredgings off Flambro' Head.

E. fulvus, Sm.—Very plentiful and fine in Ascidians.
E. crassus, Sm.—Ascidian gatherings. Sands, Hornsea. Stoneferry.
E. sculptus, Sm.—Rare. Ascidian gatherings.
E. tesselatus, Roper.—Very abundant and fine in Ascidians, sometimes nearly pure.
E. Ralfsii, Sm.—Rare. Ascidian gatherings.

ACTINOCYCLUS, Ehrenberg.

A. undulatus, Kütz.—Very frequent in Ascidian gatherings. Stoneferry, rare. Dredgings Flambro' Head. Filter Waterworks, rare.

TRICERATIUM, Ehrenberg.

T. favus, Ehr.—Very rare in Ascidians. Single frustule, Walls of Victoria Dock.
T. alternans, Bailey.—Frequent in Ascidian gatherings.
T. striolatum, Ehr.—Rare in Ascidians.
T. armatum, Roper.—Very rare in Ascidians.
T. undulatum, Brightwell.—Very frequent in Ascidians.

CYCLOTELLA, Kützing.

C. Kützingiana, Thwaites.—Very common in fresh and brackish water. Spring Ditch. Cottingham. Tetney. Stoneferry. Market Weighton Canal. Wawne.
C. minutula, Kütz.—Frequent in the Hornsea Deposit.
C. operculata, Kütz.—Frequent in clear Ditches. Spring Ditch. Cottingham. Ripley. Pure in a Drinking Trough for Poultry.
C. rotula, Kütz.—Rare. Market Weighton Canal. Hornsea Deposit.
C. punctata, Sm.—Very copious and fine in a gathering made in the Market Weighton Canal, near the River Foulney, attached to *Myriophyllum* and *Potamogeton.*
C. Dallasiana, Sm.—Rare. In a ditch running from Stoneferry to Sutton.

CAMPYLODISCUS, Ehrenberg.

C. costatus.—Frequent. Spring Ditch. Plentiful in an Iron spring, Haltenprice. Springs, Cottingham. Springs, Newbald. Market Weighton Canal. Hornsea Deposit.

C. Hodgsonii, Sm.—Not unfrequent in a Dredging made off Flambro' Head.
C. spiralis, Sm.—Not unfrequent in boggy places. Iron spring, Haltenprice, copious. Boggy place, Skirlaugh.
C. cribrosus, Sm.—Not unfrequent in salt-water Pools and Ditches, Humber Banks. Market Weighton Canal. Marfleet.
C. parvulus, Sm.—Rare. Ascidian gatherings.
C. decorus, Bréb.—Rare. In an Ascidian gathering.

SURIRELLA, Turpin.

S. biseriata, Bréb.—Not uncommon in fresh and even in brackish water. Cottingham. River Hull. Market Weighton Canal. Wawne Ferry.
S. linearis, Sm.—Not unfrequent in fresh-water localities, but always sparse. Cottingham. Beverley Parks. Wawne Ferry. Hornsea Deposit. Market Weighton Canal.
S. turgida, Sm.—Very rare in brackish water. River Hull, northward of Stoneferry. North Humber Bank, Dr. Munroe.
S. splendida, Kütz.—Not frequent. Spring Ditch. River Hull, near Stoneferry. Market Weighton Canal.
S. nobilis, Sm.—Not unfrequent. Hornsea Deposit. Cottingham. Market Weighton Canal. Stoneferry, &c.
S. striatula, Turp. — Not unfrequent in brackish water. Stallingbro'. River Hull, near Stoneferry. Humber Banks. Market Weighton Canal.
S. Gemma, Ehr.—Very frequent in salt-water Pools. North Humber Bank. River Hull, Stoneferry. Quite pure at Patrington. Breakwater near Hessle. Pure Humber Banks, Mr. Robt. Harrison.
S. fastuosa, Ehr.—Rare. Ascidian gatherings.
S. Craticula, Ehr.—Very rare in the Hornsea Peat Deposit.
S. ovalis, Bréb.—Not unfrequent in brackish water. Stallingbro'. Small Ditch near River Hull, above Stoneferry. Hornsea Deposit. Ditch running from Anlaby to Hessle Road.
S. panduriformis, Sm. — Not unfrequent in fresh water. Skirlaugh. Nettleton. Market Weighton Canal. Pure near Harrogate.
S. Brightwellii, Sm.—Not unfrequent in brackish water, but never abundant. Outlet Hornsea Meer. Hornsea Deposit. River Hull. Ditch near Stoneferry. Reservoir Waterworks. Market Weighton Canal.

S. ovata, Kütz.—Very frequent in brackish or fresh water. River Hull. Skirlaugh. Dairycoats. Nearly pure, North Humber Bank. Cottingham, nearly pure. Harrogate. Victoria Dock Timber Pond.

S. salina, Sm.—Rare. Banks of River Hull.

S. pinnata, Sm.—Not uncommon in fresh and even in brackish water, but never abundant. Risby Pond. Cottingham. Haltenprice. Ditch near River Hull. Hornsea Deposit.

S. angusta, Kütz.—Rare. Stoneferry Lane. Dr. Munroe.

S. Crumena, Bréb.—Rare. Boggy Ditch, Saltersgate. "Birk Craggs," Harrogate. Ditch at Haltenprice.

S. apiculata, Sm.—Rare. Boggy Ditch, Saltersgate.

S. minuta, Bréb.—Rare. Thornton-le-Moor, Mr. Robt. Harrison. Victoria Dock Timber Pond, Dr. Munroe.

TRYBLIONELLA, Smith.

T. gracilis, Sm.—Not uncommon in brackish water. Stoneferry. Humber Banks. Hornsea Deposit. Market Weighton Canal. Very abundant and fine in a small Ditch northward of Stoneferry.

T. marginata, Sm.—Not uncommon in brackish and fresh water. Stallingbro'. River Hull above Stoneferry. Outlet Hornsea Meer. Haltenprice. Market Weighton Canal. Pond near Stepney.

T. constricta, Greg.—Rare. Ascidians.

T. punctata, Sm.—Rare in brackish water. Market Weighton Canal. Humber Bank, in slides sent me by Professor Arnott, collected by Dr. Redfern in 1853. Pond, Stepney, Lane.

T. acuminata, Sm.—Not uncommon in brackish water. Rare in fresh water. Ditches near Stallingbro'. Cottingham. Timber Ponds, Mr. Robt. Harrison.

T. angustata, Sm.—Rare. Market Weighton Canal. Beverley Parks. Anlaby-Road, Dr. Munroe. Thornton-le-Moor.

T. apiculata, Greg.—Frequent in a gathering, Patrington.

T. Scutellum, Sm.—Very rare. North Humber Bank, Mr. Robt. Harrison.

CYMATOPLEURA, Smith.

C. Solea, Sm.—Very common in fresh-water ditches. Skirlaugh. Hornsea Deposit. Wawne. Reservoir Waterworks. Very abundant near Cottingham. Haltenprice. Spring Ditch. Beverley Parks, &c.

C. apiculata, Sm.—Rare. Cottingham. Skirlaugh. Clay Pits, Nettleton.

C. elliptica, Sm. — Very common in fresh-water ditches. Risby Pond. Wawne. Haltenprice. Peat Deposit, Hornsea. Cottingham. Beverley. Market Weighton Canal. Spring Ditch.

NITZSCHIA, Hassall.

N. sigmoidea, Sm.—Very frequent in fresh clear water ditches. Cottingham. Risby Pond. River Hull, Wawne. Spring Ditch, very abundant. Harrogate. Beverley Parks. Haltenprice.

N. Brébissonii, Sm.—Local but plentiful in a small brackish ditch near the River Hull, above Stoneferry.

N. socialis, Greg.—Not uncommon in a Dredging, Flambro' Head.

N. macilenta. Greg.—Rare in a Dredging, Flambro' Head.

N. Sigma, Sm.—Very frequent in salt water pools and ditches. Dairycoats, under Railway arch. River Hull, frequent. Victoria Dock Piers. Grimsby. Timber Ponds, Victoria Dock.

N. spectabilis, Sm.—Rare in a brackish ditch near Stoneferry.

N. linearis, Sm.—Not uncommon. Haltenprice. Cottingham. Beverley Parks.

N. tenuis, Sm.—Very common. Haltenprice. Beverley Parks. Spring Ditch. Nettleton. Cottingham, very frequent.

N. spathulata, Sm.—Rare. On Breakwater Hessle, Mr. Robt. Harrison. Sands, Hornsea. North Humber Bank, Dr. Munroe.

N. angularis, Sm.—Not unfrequent in salt water. Timber Pond, Victoria Dock. Piers, Victoria Dock. Ascidians.

N. lanceolata, Sm.—Occasionally from Ascidians.

N. Amphioxys, Sm.—Not unfrequent, but always much mixed. Soil, Benningholme Carrs. Nettleton. Harrogate. Cottingham. Wawne. Killinghall. Market Weighton Canal.

N. vivax, Sm.—Copious in a brackish ditch near River Hull, above Stoneferry.

N. parvula? Sm.—Not uncommon in brackish or fresh water. Pure in a Pool at Withernsea. Victoria Dock Timber Pond. Cottingham.

N. minutissima, Sm.—In a trough for poultry.

N. vitrea, Nor. M. S.—Very local. In a small brackish ditch near River Hull, above Stoneferry.

N. dubia, Sm.—Very common in brackish or fresh water. Stallingbro'. Cottingham, very pure. Humber Banks. Tetney. Ditch near River Hull, above Stoneferry, abundant. Wawne. Haltenprice. Dairycoats. Pure in a ditch running from Anlaby to Hessle Road.

N. dubia Var. β Sm.—Not uncommon in fresh or brackish water. Skirlaugh, nearly pure. Clay Pit, Nettleton. Brackish ditch near River Hull. Pond in Stepney Lane.

N. bilobata, Sm.—Not unfrequent in brackish water. Pure under Railway arch, Dairycoats. Stallingbro'. Small ditch near the River Hull. Outlet, Hornsea Meer.

N. cursoria=Bacillaria cursoria, Donk.—Rare. In a sand-gathering, Hornsea.

N. plana, Sm.—Not frequent. Brackish ditch near River Hull.

N. virgata, Roper.—Rare. Sands, Hornsea. Dredgings off Flambro' Head.

N. insignis, Greg.—Rare. Dredgings off Flambro' Head.

N. Closterium, Sm.—Not unfrequent. Salt and brackish water. Humber Banks. Marfleet. Grimsby. Ascidians.

N. reversa, Sm.—Rare. Ascidians. Ditch near Stoneferry.

N. acicularis, Sm.—Not frequent. Under Railway arch at Dairycoats. Cottingham, near Mr. Wilson's Grounds.

N. Tænia, Sm.—Not uncommon. Humber Bank. Pure near Marfleet Clough.

N. palea, Sm.—Not common. Cottingham. Pure near the Waterworks, Stoneferry.

N. curvula, Sm.—Rare. In fresh and brackish water. Beverley Parks. Ditch running from Stoneferry to Sutton, Mr. Robt. Harrison.

AMPHIPRORA, Ehrenberg.

A. alata, Kütz.—Very frequent in brackish water. Humber Banks, often pretty pure. Marsh Chapel. Breakwater, Hessle. Ditch near River Hull, above Stoneferry. Victoria Dock Timber Pond.

A. paludosa, Sm.—Not unfrequent in brackish water. Ditch running from Stoneferry to Sutton. Ditch near River Hull. Humber Banks. Ditch running from Anlaby to Hessle Road.

A. "didyma, Sm.—Rare. Humber Banks," Dr. Munroe.

A. vitrea, Sm.—Rare. Dredgings off Flambro' Head.
A. constricta, Ehr.—Very common in brackish water. Pure in Victoria Dock Timber Pond. Marsh Chapel. Pure near Marfleet. Garrison Moat. Dairycoats, under Railway arch.
A. lepidoptera, Greg.—Rare. Dredgings, Flambro' Head.

AMPHIPLEURA, Kützing.

A. pellucida, Kütz.—Very local. Nettleton. Very pure near Cottingham, Mr. Robt. Harrison. In abundance Risby Pond, near a submerged Willow Tree. Between Spring Head and Cottingham, Dr. Munroe. Very copious and fine, Pond, Botanic Gardens.
A. sigmoidea, Sm.—Rare. Ascidians.
A. danica, Kütz.—Not unfrequent. Pure near Tetney Lock. Pure, Grimsby. Humber Banks.

NAVICULA, Bory.

N. rhomboides Var. β Sm.=*interrupta*, Greg—Very rare. In a ditch between Hedon and Paull, Dr. Munroe. Salt-water ditch at Dairycoats, Mr. Robt. Harrison.
N. amphigomphus, Ehr.—Not common. Cottingham. Wawne. Harrogate.
N. lanceolata, Kütz.—Very local. Very copious in a gathering from Beverley Parks, near Woodmancy.
N. Crassinervia, Bréb.—Not unfrequent in fresh water, but always much mixed. Nettleton. Saltersgate. Cottingham. River Hull.
N. cuspidata, Kütz.—Frequent in fresh water. Spring ditch. Cottingham. Hornsea Meer. Hornsea Deposit. Risby Pond. Pure in a Puddle near "Birk Cragg," Harrogate Haltenprice. Stepney.
N. rhynchocephala, Kütz.—Not unfrequent, but never abundant. Cottingham. Risby Pond. Harrogate. Haltenprice. Market Weighton Canal.
N. Liber, Sm.—Rare. Dredgings off Flambro' Head.
N. firma, Kütz.—Not uncommon, but always much mixed. Risby Pond. Cottingham. Haltenprice. Spring Ditch.
N. elliptica, Kütz.—Very frequent, though always much mixed. Hornsea Deposit. Springs at Haltenprice and Newbald. River Hull. Reservoir Waterworks. Market Weighton Canal. Cottingham.
N. ellipsis, Sm. M. S.—Plentiful in a gathering from the Piers, Victoria Dock.
N. Smithii, Bréb.—Not unfrequent in brackish water ditches. Ditch near River Hull. Ascidians.

N. Smithii, var. β, *fusca*, Greg.—Ascidians.
N. Smithii, var. γ, *nitescens*, Greg.—Ascidians.
N. gastroides, Greg.—Scarce. Small ditch near Stoneferry.
N. minutula, Sm.—Not unfrequent in brackish water. Stoneferry. Ditch near River Hull. Humber Bank. Marsh Chapel. Tetney.
N. Jennerii, Sm.—Not unfrequent in salt and brackish water. Humber, near Stallingbro', covering the mud for miles. River Hull, Stoneferry. Marsh Chapel. Dairycoats. Grimsby.
N. Westii, Sm.—Rare in brackish water. River Hull. Stallingbro'.
N. elegans, Sm. Local in brackish water. Very copious in a stinking marsh Tetney. Small ditch near River Hull, beyond Stoneferry.
N. palpebralis, Bréb.—Rare. Mr. Robt. Harrison vide Smith's Synopsis. South Humber Bank, Dr. Munroe.
N. Semen, Kütz.—Local. Not unfrequent in the Hornsea Peat Deposit. Cottingham. Risby Pond.
N. affinis, Ehr.—Rare. Spring Ditch. Stream at Cottingham.
N. inflata, Kütz.—Not unfrequent in fresh-water gatherings. Wawne. Killinghall. Market Weighton Canal. Beverley Parks. Frequent in Cottingham gatherings.
N. gibberula, Kütz.—Frequent in fresh and brackish water. Risby Pond. Skirlaugh. Nettleton. Cottingham. Hornsea Meer. Hornsea Deposit. Copious in a brackish marsh, Tetney. Ditch near River Hull, above Stoneferry. Wawne. Haltenprice. Spring Ditch. Market Weighton Canal.
N. amphirhynchus, Ehr.—Not uncommon, though always much mixed. Nettleton. Cottingham. Skirlaugh. Harrogate.
N. producta, Sm.—Not uncommon, though always sparse. Boggy place, Skirlaugh. Springs near Cottingham. Haltenprice. Peat Deposit, Hornsea.
N. ambigua, Ehr.—Rare. Ditch near Stoneferry, leading to Sutton. Hornsea Peat Deposit.
N. Amphisbæna, Bory.—Very frequent both in fresh and brackish water. Copious in a ditch near Stoneferry. Nettleton. Humber Bank. Cottingham. Marsh Chapel. Tetney. Copious near Harrogate. Ripley. Haltenprice. Market Weighton Canal.
N. sphærophora, Kütz.—Rare in fresh water. Haltenprice. Nettleton. Hornsea Peat Deposit.
N. tumens, Sm.—Local in brackish water. Stinking marsh at Tetney. Ditch near River Hull, above Stoneferry.

N. punctulata, Sm.—Rare in brackish water. Stallingbro'. Marsh Chapel.

N. pusilla, Sm.—Not uncommon in brackish or fresh water. Wawne. Market Weighton Canal. Small ditch near River Hull, above Stoneferry. Cottingham. Thornton-le-Moor, Mr. Robt. Harrison.

N. tumida, Sm.—Rare. In a gathering from Cottingham.

N. dicephala, Kütz.—Rare. In a ditch near the Farm House Haltenprice. Cottingham.

N. cryptocephala, Kütz.—Very abundant in almost every salt and brackish water ditch. River Hull. Humber Banks, pure. Victoria Dock Timber Pond. Market Weighton Canal. Dairycoats.

N. bacillum, Ehr.—Rare in Hornsea Peat Deposit.

N. lævissima, Kütz.—Frequent in fresh-water gatherings, though never abundant. Rocky stream, Saltersgate. Nettleton. Cottingham frequent. Hornsea Peat Deposit. Haltenprice. Wawne.

N. limosa, Kütz.—Very scarce in fresh water. Spring at Cottingham. River Hull, near Wawne.

N. Hennedyii, Sm.—Rare in Ascidians.

N. Lyra, Ehr.—Ascidians. Dredgings, Flambro' Head.

N. Lyra, var. β, Greg.—Rare, Ascidians.

N. humerosa, Bréb.—Not unfrequent in a sand-washing, Hornsea. Tetney.

N. Crabro, Ehr.—Rare, Ascidians.

N. didyma, Kütz.—Not unfrequent in salt and brackish water. Frequent in a ditch near River Hull, above Stoneferry. Marsh Chapel a good gathering. Grimsby. Abundant in Ascidians.

N. binodis, Ehr.—Very rare in fresh-water gatherings. Beverley Parks, near Woodmancy. Market Weighton Canal. Thornton-le-Moor.

N. Bombus, Ehr.—Rare in Ascidians.

N. Scita, Sm.—Very local in fresh-water gatherings. Springs at Newbald. Cottingham near Springs.

N. Barclayana, Greg.—Frequent in a sand-gathering, Hornsea.

N. mutica, Kütz.—Rare. Posts in salt water, Dairycoats.

N. libellus, Greg.—Rare, Ascidians.

N. retusa, Bréb.—Rare, Ascidians. Dredgings, Flambro' Head.

N. apiculata, Bréb.—Rare. In an Ascidian gathering.

N. bacillaris, Greg.—Local in fresh water. Cottingham. Frequent in a spring two miles north of Cottingham.

N. follis, Ehr.—Rare. Market Weighton Canal. Beverley Parks.

N. forcipata, Greville.—Not common in Ascidians.
N. lepida, Greg.--Very rare in fresh water. Spring Ditch.
N. granulata, Bréb.—Rare. In a sand-gathering, Hornsea.
N. pectinalis, Sm.—Rare. Sand-washing, Hornsea.
N. æstiva, Donk.—In a sand-gathering from Hornsea.

On the Reproductive Process in the CONFERVOIDEÆ (with part of Plate VI). By T. C. DRUCE, ESQ.

(Read January 11th, 1860.)

THE study of the reproductive process in the Confervoideæ has occupied the attention of observers so eminent, that it is with very great diffidence I venture to lay before you the present imperfect observations; but two considerations, arising one out of the other, impel me to this course. The first, that whatever may be the real importance of the facts I shall have the honour of submitting to you, they are at least recorded faithfully, and have assumed a consistency and strength I little expected at the commencement of a somewhat desultory course of study. The second is, that as the present and coming season is favorable for the observation of the resting spores, I hope to induce many more observers to regard these organisms, humble in the scale of creation, but full of the highest physiological interest, and possessed moreover of beauty sufficient to reward the mere searcher after pretty objects, for devoting to them a somewhat less desultory attention than usual. I would commence the remarks I have to offer to you by pointing out a few of the difficulties with which the path is beset in this department of research. These are of two kinds; the first, pregnant with snares for the inexperienced observer, arises from the tendency of the vital protoplasm to pseudo-organization; for it is frequently overlooked that this life-blood of the vegetable world possesses as great a formative capacity as the blastema of animal life; hence are presented many appearances otherwise unaccountable. I have seen the contents of

a ruptured cell of Vaucheria assume the form of young encysted fronds of Pediastrum so nearly, that had I not myself seen the process, I should have had no doubt in so considering them; the contents of Cladophora in like manner bear an exact resemblance to young Palmellæ. I might continue the list of these false appearances; but, not to multiply instances, I would just remark that in Spirogyra, the instant a cell is injured, or the density between the contents and the surrounding medium altered, the spires become flaccid and exhibit a disposition to separate into globular aggregations of chlorophylls, and around each will be found a transparent protoplasmic layer. As this becomes inspissated, it assumes the appearance of a true cellulose envelope, and may become produced into stellate processes; and thus the history of many phenomena assumed to be connected with reproduction may be elucidated. I have no hesitation in asserting that almost all the obscure encysted bodies of algologists are to be accounted for in this wise. Again, in decaying cells, it is not unusual to find the contents resolved into a fibro-molecular mass, exhibiting a motion very similar to the swarming in Desmideæ; this is doubtless the ordinary molecular motion, but it is very deceptive. The second class of difficulties is formidable to the physiologist and practised observer, and consists in this (in the words of the authors of the 'Micrographic Dictionary'), viz., the great apparent diversities that occur in the physiological phenomena presented by what at first appear like identical structures. I shall not touch upon these now in detail, as we shall have to dwell upon some of them at a later stage in our inquiry, but pass on to consider, first, the premises upon which, in the reproduction of Confervoid Algæ, observers may hope to arrive at a right conclusion. To do this effectually, we must, I think, first look upon the distinctive peculiarities of the class before us, as bearing upon the phenomena we should expect to find connected with their reproduction; and this we may do without departing from legitimate analogy. These are the extraordinary extent of germ capacity conferred by a single generative act, and the continued nisus to vegetative multiplication rather than to generation, so long as favourable conditions are supplied; the independent vitality of the component parts of even the higher families, and the complete individuality of the phytoids of the lower; and lastly, the great resemblance, both materially and physiologically, between the protoplasm of the Algæ and the sarcode of the lower animals. From these characteristics we may infer, first, that in many species the true generative act would be com-

paratively seldom observed; and secondly, that from the combined conditions of the nisus towards gemmation, and the multiform variableness of the plastic element concerned in these changes, we should often find the true reproductive phenomena obscured by the differing conditions and fertility of resource exhibited by those of gemmation and vegetative multiplication. The uniform simplicity of plan, upon which these orders are developed, would moreover lead us to expect a corresponding uniformity as to the organs of reproduction throughout the group, more or less completely differentiated, but still identical in function and purpose; it will, therefore, not be unscientific to consider these, first, as we find them in the highest families of the order, with the intention of inquiring how far it is probable that, to discover the truth, we must look for their homologues in the lower. If this mode of investigation be legitimate, it may both lead to the solution of the problem of the reproduction of the Confervoid Algæ, and, without pretending to account for multifarious occurrences connected with them, may enable us to discriminate between essential and non-essential phenomena. The Rhodosperms I pass by, as they possess an indication of affinities higher than any of the aquatic Cryptogamia; and would direct your attention to the Melanosperms, as represented by the genus Fucus, in which we find the provisions for reproduction to be as follows:—First, oosporanges; second, conceptacles; third, antheridia. I believe I am justified in asserting that these several organs rather appear to be evolved upon a higher type than those of Confervoideæ than to be so in reality. It has been ordained that the forests of the deep should be developed upon the Cryptogamic type; but it is evident that the ability of each cell to produce zoospores, or to become a spore or antheridium, would be here incompatible with the dimensions to which these plants attain, and to fulfil their purposes. We therefore find all the fertile cells, whether gonidial, sperm, or germ, collected together in specialized parts of the organism; but the specialization stops with the locality, the spores being extruded, whether singly or in octospores, finally without a membrane, and afterwards acquiring true cellulose envelopes, after the manner of Confervoideæ. The oosporanges are formed merely by the breaking up of the cell-contents of a mass of cells into zoospores, and the process is in every respect comparable with that of the unicellular Algæ; and although the antherozoids are developed from articulated filaments, the antheridia are budded off from these in a manner similar to the horns of Vaucheria. I would also

mention here, as a point to remember in connection with the process in Confervæ, that the antheridial capsules, though quickly dissolved, are detached with the contained Antherozoids. I hope to be able to show that a similar process in all essentials exists in Spirogyra, and, as seen by Pringsheim, in Œdogonium, and by Cohn, in *Sphæoplea annulina*. I have selected this genus Fucus—widely separated from my immediate subject—because the relation of the several organs is indubitably well known, and the fertilization by the antherozoids often observed. I shall now proceed to the Siphonaceæ, in which we have again the threefold type—gemmation by zoospores, and reproduction by spores and antheridia, as observed lately in all its details by Pringsheim. I would here remark upon two points, viz., that the hooklike antheridia and spores are both formed by pouchlike protrusions from the main filament, as if for the formation of branches; the process is therefore vegetative, until the shutting off of the contents of the new cells by septa. I mention this here because the outgrowth of the fructification renders the nature of the process evident, and it does not seem impossible that the antheridia may occasionally stop short of perfection, and be converted into the small zoospores of certain Confervæ, and that the spores themselves, up to the time of fertilization, or in default of it, may, by the amount of vegetative power inherent in them, be subdivided into zoospores, and thus account for much of the confusion at present existing between true spores and sporangia, which last I have little doubt true spores never become. In the curious Hydrodictyon, the formation of resting spores has not been discovered, but there is no doubt, from analogy, that they exist. There is, however, one point to which I would direct your attention, viz., the smaller zoospores or microgonidia, and, so far as at present known, their ultimate fate; these, after moving for some time, fall to the bottom, and become encysted in little green heaps. This I believe to occur in other of the Confervæ, and to be no less than an encysted form of the antheridial capsules; and that the fecundation of the resting spores may take place either before the formation of the spore coat at all, or in the spring when it is ruptured by their expansion. I pass over the Batrachospermæ and Chætophoraceæ, in which the generative act has not yet been witnessed, with one observation, viz., that if, as Dr. Carpenter has suggested, the setiform terminal cells of the latter be antheridia, a connecting link would be formed towards the lower Confervoideæ, in the less degree of differentiation between them and the hooklike

antheridia of Vaucheria. It will be more consonant with my purpose to consider the Confervaceæ and Zygnemaceæ together as one class, waiving any precedence in point of classification between them in virtue of their near relation one to the other in vital phenomena; and that this is nearer than is generally imagined, I desire to show, by weighing the value of conjugation (the prominent characteristic of the latter family), as a true generative act, complete in itself. I should have great hesitation in propounding an assertion so heterodox, if I were not backed by the weighty authority, Schleiden, but I truly believe that conjugation is in no case or class essential; the obvious and rough analogy presented by the coalescence of two cells having blinded many observers to the evidence upon the other side.

In reference to Spirogyra, Schleiden says, "I have observed the following cases, which prove how inessential this process really is. Two cells were combined with the papilla of a third cell, and thus arose four spores—one in each of the first-named cells, and two in the third. Three cells were combined, and the result was the formation of one spore in the space formed by the three papillæ. Again, two cells were combined; there appeared two spores, and a third spore in the cavity of the papilla. Two cells combined together, and here a spore was formed in each one. Another instance very frequently occurred, in which one cell that had a papilla, which did not combine with another, exhibited a spore formed within the cell. Finally, it sometimes happens, although but rarely, that a spore is formed without the cell having formed any papilla." This paragraph I quote entire, because it affords, in better terms than I could have described, a complete epitome of my own experience. I have only to add that, having witnessed in many cases the endochrome in the very act of transference, I am certain that the assertion of Itsighsohn, that in one cell the contents are broken up into moving spiral filaments or antherozoids, is void of foundation; in fact, that observer having been probably deceived by an injured filament, the disintegrated contents of which exhibited molecular motion,—a source of error referred to in my introductory observations. The occurrence of non-conjugatory species in these Conjugateæ is surely sufficient evidence; and when, in addition to this, we find no approximation to this process among the multitude of Confervoideæ, so closely allied in other characteristics, we may surely consider the case proved against its essentiality.

The conjugation, so far as seen among the Diatomaceæ, strengthens this view; for here we have the spores resulting

from an altered condition of two halves of a single frustule, as in Melosira and Orthosira, and probably throughout the filamentous group. The same process has been observed among certain of the Naviculæ, in Acnanthes, and other organisms; and it may, I think, be safely concluded that if conjugation were the process which, in one shape or other, the student had to discover as the true generative act among the Confervoideæ, its essential conditions would not vary; and, moreover, considering that the majority of these organisms are admitted to be unicellular, and the conditions of a true generative act consist in the union of two cells of different characteristic endowments, although each cell may produce many by internal gemmation, it is difficult to conceive that the product of this vegetative multiplication can ever result in a sperm and germ cell from the same parent. The theory I would very diffidently offer to your notice is—that as a certain definite amount of germ capacity only is conferred by each generative act, the tendency of each growth by vegetative multiplication is towards the degeneration of the organism. This is evidently true and palpable to any one who has grown Confervæ in an aquarium, where the nutritive elements are not so abundant as in their native waters. In order, therefore, to prolong this power of multiplication, two cells combine to produce one, by the mere fusion of their respective cell-contents; and in cases where two spores are formed, and, as we have seen not unfrequently in Spirogyra, after fusion the contents part again into two reproductive bodies. I would further venture to propose that the germ cells in these orders are very imperfectly differentiated, and that up to the period of fecundation there is no real difference between the preparation of the cell-contents for zoospores and real spores; and that these unfecundated spores may become encysted, and are sporangia, while those fecundated are, in all cases, in due time developed in the likeness of their parents. A curious confirmation of this doctrine here occurs to me in the only instance of conjugation, so called, among a class of animals so high as the Articulata,—one of the Trematode Entozoa, *Diplozoon paradoxum* a parasite upon the gills of certain fishes, which in its young state, Diporpa, is destitute of the organs of reproduction, but at a certain stage of their existence two previously independent individuals are partially fused into each other, and become one bi-sexual organism. Here surely we may conclude that each of these Diporpæ does not in itself possess sufficient germ capacity to become perfect, but that the united capacity of both affords the requisite accumulative power; and here there can be no question as to

where the true generative act intervenes, as the phenomenon occurs in a class so highly organized as to afford us unmistakeable ova and spermatozoa in their respective organs. Upon this plan there is nothing extraordinary in the occurrence of spores in each cell of a Conferva (as in *Spirogyra mirable*, and *Mougeotia notabilis*), or in both cells of a conjugating filament, or in a cell to which the papilla has not reached that of the one opposite. And indeed, finally, I would say that there is not anything remarkable in any spherical aggregations of endochrome within cells, for their appearance is often the precursor of decay in injured filaments. So far we have had to deal with facts well ascertained, however open they may be to difference of interpretation. I have now to present to you occurrences resting principally upon my unsupported observations. These, however, have assumed a consistency which, when coupled with my previous conviction that conjugation is not the true reproduction in Confervæ, have made me deem these observations of sufficient importance to submit to your consideration. The late Professor Henfrey mentions, in the 'Micrographic Dictionary,' as an abnormal occurrence in Spirogyra, the conversion of the endochrome in certain cells into large colourless zoospores; this it has been my good fortune to witness in so many instances, that it is impossible to regard it otherwise than as connected with reproduction. It has also presented itself in Œdogonium, and the process is as follows, in both cases. The Chlorophyll vanishes by degrees from the cells, which become at last diaphanous; though obviously still full of cell-contents, the characteristic nucleus of Spirogyra is enlarged, and the protoplasmic threads thickened and connected with nucleus-like aggregations of protoplasm at the sides; nuclei and protoplasmic threads not so definitely arranged, but still obvious, are to be seen in Œdogonium, and the contents at last break up into the large colourless zoospores above mentioned; these grow in size, become spherical, and are gradually filled with a purplish black endochrome, which at last becomes dense, though evidently granular; and finally the capsules burst and discharge minute bodies, moving actively, into the cavity of the cell; although my power of 350 diameters was insufficient to detect any cilia. They most resemble the spermatia of lichens. This I believe to be the antheridial function in Spirogyra, and so far in all essentials it agrees with the account of Pringsheim on Œdogonium, excepting that the antheridial capsules discharge their contents before leaving the parent cell; but the foregoing process, I have said, obtains also in Œdogonium, and is at first sight

difficult to reconcile with it. Recollecting, however, that in Œdogonium the ordinary zoospore is formed from the whole contents of the cell, we may conceive each characium to be the primordial utricle, full of antheridial capsules, which burst within it, freeing the antherozoids into its cavity before the dehiscence of the lid. This process I have also been so fortunate as to witness; the characium being full of globular bodies, and presenting a totally different appearance to that of the same phytoid at a later stage, when the antherozoids are swarming up to the lid, after the manner of the Desmideæ; the only difference being, that this aggregation of the antheridial capsules is discharged from the parent cell at an earlier period, and provided with sufficient vegetative life to enable it to elaborate the antheridia independently.

It further appears to me, that the generative act in Confervæ may, and probably does, take place at all periods of the year; that spores, formed by conjugation and otherwise in the spring, are fecundated at once by the antherozoids after the manner I have named; whilst in the summer, in Œdogonia the vegetative process is too active to wait for the development of the antheridia within the parent cell; the cycle of their life hurries on, and the whole aggregation of antheridial capsules is emitted as a zoospore. The resting spores only attract attention in the autumn, because their appearance is more distinctive, and they are provided with additional envelopes to enable them to withstand the rigour of winter. Other occurrences there are more difficult to account for, but the supposition that the antheridial capsules may become encysted for the winter, like the resting spores, will go far to explain it, if it may only be received. I have noticed a swarming of minute gonidia in quite young cells of Œdogonium, radient with Chlorophylls, these atoms crowded to one end of each cell as if to escape; but of this there was no probability; and perhaps, although I do not speak this upon the authority of further observations, these represented the microgonidia of Hydrodictyon, but became encysted within the parent cells. Pringsheim has noticed that encysted bodies in Spirogyra produced small zoospores. Now I have no doubt that here the encysted bodies are the large colourless zoospores; the development of the antherozoids being arrested by the approach of winter. In *Sphæroplea annulina*, in which the only difference seems to be that the primordial utricle forms one antheridial capsule, instead of subdividing into many, Cohn has witnessed the fertilization of the spores by the antherozoids resembling exactly those I have seen in Spirogyra and Œdogonium. In Chlorosphæra, Professor

Henfrey has described antheridia of somewhat higher grade, having definite tubular apertures, and discharging similar corpuscules, occurring simultaneously with the resting spores; so that hardly any doubt can remain here as to their co-relationship. I should here mention, that Professor Henfrey suggests an affinity with the colourless zoospores witnessed by him in Spirogyra. I beg therefore to disclaim any appropriation of discovery in these observations, only believing I have been so fortunate as to continue them one step further. I have seen a similar process in Cladophora, and in a small branched Conferva allied to it: the capsules were adherent after the manner of those of Œdogonium, excepting that they were affixed by a point incised, instead of rootlike processes; but the contents were freed by the dehiscence of a definite lid, and corresponded in all other respects entirely.

In *Closterium moniliferum* I have found the chlorophyll to disappear, as in Spirogyra, and the spheroidal bodies rolling to and fro in the frustule, filling by degrees with the purplish-black cell-contents, and finally bursting into antherozoids.

In the last number of the 'Microscopical Journal,' Mr. Archer has described and figured bodies apparently similar to those I have mentioned, in an abnormal Tetmemorus, but also affirms it to be a frequent occurrence in Tetmemorus, Micrasterias, and Euastrum, and he has also seen a similar phenomenon to that which Professor Henfrey describes in Chlorosphæra, in Closterium, viz., the formation of flask-shaped bodies, discharging antherozoids, which in both cases are, I would suggest, the encysted antheridia. Cohn's account of the formation of the antheridia and antherozoids in Volvox, agrees also in all main points with my account in Spirogyra and Œdogonium. In Œdogonium I have had the good fortune to witness, I believe, the actual fecundation, a drawing of which I have attempted, which has at least the merit of having been drawn from life.

These are my facts; and, if the interpretation I have placed upon them be correct, they serve to show that, in the several classes named, the fructification attains essentially to the same degree of organization as that of the higher Algæ; and as approximate occurrences have been from time to time observed in almost all of the Confervoid Algæ, the type may fairly be considered universal to the group. The summary of the foregoing is—first, that conjugation is not the generative act in organisms in which it occurs, and not essential, though it may be subservient to the preparation of true spores for fecundation. Secondly, that true fecundated spores

are never sporangia, although those unimpregnated may remain in the condition of encysted gonidia, or, under favorable circumstances, subdivide at once into zoospores. Thirdly, that the true spores are fecundated by antherozoids developed in capsules, at first themselves motile, and afterwards either inside the parent cell, as in Spirogyra, or outside, as generally in Œdogonium, freeing their contents either by the rupture of the cell-wall or the dehiscence of a definite lid. Fourthly, that the antheridia may become encysted in the autumn, as well as the resting spores, and impregnation take place either before the formation of the envelopes of the spore in the autumn, or in the spring, when these are ruptured. (See Plate VI.)

In conclusion, I am conscious how little I have performed towards the fulfilment of my programme at the outset, and how easily I may be condemned upon my own premises; but I proposed it to myself rather as an indication towards right investigation, than with any hope of completing it myself on the present occasion. Finally, I lay claim to very little novelty in the foregoing observations, my object having been rather the attempt to consolidate and connect together facts already known, than to proclaim a new thing; and I do desire to call the attention of microscopists who have no special study, to these lowly organisms, not merely that it is a favorable field for research, offering the charm of novelty and ever-changing beauty, but also because the study is full of the highest physiological interest; for from unicellular organisms is there the greatest chance of discovering the great fundamental, and as yet hidden, laws of life.

MICROSCOPICAL SOCIETY.

ANNUAL MEETING.

February 8th, 1860.

DR. LANKESTER, President, in the Chair.

REPORT *of* COUNCIL.

"IN accordance with annual custom, the Council have to make the following report:

The number of members reported at the last anniversary was . . .		276
There have been since elected .		28
Making a total of		304
This number has to be reduced by—		
Deceased	7	
Withdrawn	12	=19
Leaving a final total of . . .		285 as the present number of members of the Society.

"The Library has been increased by about 160 works, including serials—chiefly presents; 77 of them consist of catalogues of objects of natural history, presented by the Trustees of the British Museum; 14 others have been purchased with a fund arising out of the sale, to members, of the early 'Transactions,' at a reduced price, which fund it is intended shall be applied solely to the supplying the Library with such works as it may be thought desirable to add to it. There still remains a considerable surplus available for this purpose.

"The collection of objects also has received many additions.

"The arrangements for the distribution of the 'Journal' continue the same as last year."

AUDITORS' REPORT.

Dr. From FEBRUARY 15, 1859, to FEBRUARY 8, 1860. **Cr.**

RECEIPTS.				£	s.	d.
Balance from previous year				35	17	5
Entrance of members				21	0	0
Compositions				63	0	0
Annual payments—						
For 1853	£1	1	0			
1854	1	1	0			
1855	1	1	0			
1856	1	1	0			
1857	4	4	0			
1858	17	17	0			
1859	108	3	0			
1860	33	12	0			
				168	0	0
Library Account—						
Sale of Transactions	20	0	0			
Ditto by Van Voorst	2	2	0			
	22	2	0			
Subscription to Ray Society—						
Books and Binding	13	8	0			
Balance				8	14	0
Dividends on Consols				13	15	5
				£310	6	10

PAYMENTS.				£	s.	d.
By Salary of Curator, one year				6	12	6
„ Assistant-Secretary				21	0	0
Commission on Collections				12	10	6
Printing, Stationery, Postage, and Carriage				10	2	0
Microscopical Journal—						
The Editors	£123	10	0			
Delivering ditto	9	8	2			
				132	18	2
Purchase of £66 11s. 7d. Consols				63	0	0
Expense of Soirée at South Kensington Museum	106	7	4			
Received for additional admissions	77	5	6			
Balance				29	1	10
Expenses at Burlington House				9	5	0
General Balance, carried forward to next year				25	16	10
				£310	6	10

Examined with the vouchers and found to be correct. { JOSEPH GRATTON, RICHARD BECK.

Report *of the* Library Committee *of the* Microscopical Society.

"Since the last Report, some valuable additions have been made to the Library, comprising sixteen volumes, and 143 pamphlets presented, and sixteen volumes purchased, or exchanged for old numbers of the 'Transactions' or 'Journal.' The whole of the books in the Library have been examined; fifty-six volumes have been bound; the collection of pamphlets has been classified, and bound in five volumes; and a catalogue of the whole has been prepared, printed, and presented with the 'Journal' to the members.

"The Committee draw especial attention to the presentation by W. S. Sullivant, of the United States, of seven works on Mosses, &c.; and to seventy-seven numbers of the British Museum publications, by the Trustees.

"The Committee trust that arrangements will be made at an early period to provide accommodation for the books in the rooms they at present occupy, so as to be more available to the members.

"In conclusion, they strongly recommend that the following works should be added to the Library as soon as possible: 'Der Organismus der Infusionsthiere,' by Dr. F. Stein; 'Die Kieselschaligen Bacillarien,' by F. T. Kützing; 'Mikrogeologie,' by Dr. C. G. Ehrenberg.

"F. C. S. Roper.
Geo. E. Blenkins.
J. H. Roberts.
R. J. Farrants."

The President delivered the following address:

The President's Address *for* 1860.

By Dr. Lankester.

Gentlemen,—It gives me great pleasure to address you at the close of my term of presidency, after you have heard the Reports of your Council and Treasurer, and which represent our Society in a condition which commands our mutual congratulations. At the present we have a larger number of members than at any previous time in the history of our Society. However much we may regret the withdrawal of

some of our members, the addition to our numbers more than compensates for the loss. It is, however, always a painful task on these occasions to have to reflect that our numbers are diminished by the hand of death. During the past year seven of our members have been thus removed, and amongst them you will recognise some of the earliest and most active members of our Society. They are Mr. J. N. Furze, Professor Henfrey, Mr. Andrew Ross, Mr. E. Speer, Mr. W. Stuart, Mr. Richard Taylor, and Dr. H. Rees.

Some of these gentlemen demand from me more than a passing notice; and I would first refer to Professor Henfrey, whose death at an early age we have not only to deplore as a loss to ourselves, but to science generally. Although, from disease of the lungs contracted in youth, he was never robust, he yet by unceasing industry acquired for himself a European reputation. He was originally intended for the medical profession, and studied at Bartholomew's Hospital; but the state of his health induced him to abandon the arduous duties of practice, and devote himself entirely to science. The branch of study to which his tastes led him was that of botany, and in this science more particularly he attained his great distinction. One of his earliest works was on 'Anatomical Manipulation,' which he wrote in conjunction with Mr. Alfred Tulke; this was published in 1844. About this time he was appointed Botanist to the Geological Survey of the United Kingdom; he held this post but for a short time. He was subsequently appointed lecturer on Botany at the Middlesex Hospital, and at the St. George's Hospital School of Medicine. In 1847 he published his 'Outlines of Structural and Physiological Botany;' this work was illustrated by plates executed by himself. Several of these plates were devoted to the illustration of the microscopic structure of plants, and were faithful representations of his own observations. He had at this time carefully investigated the views of Schleiden and Hugo von Mohl on the cytoblast and primordial utricle, and his work, at the time it was published, was a faithful epitome of the various observations that had been made on the histology and development of vegetable tissues. This work laid the foundations of one much more extended and complete, which he afterwards published in 1857, with the title, 'An Elementary Course of Botany, Structural, Physiological, and Systematic; with a brief outline of the Geographical and Geological Distribution of Plants.' This work, which gives the most complete view of the histology and development of plants in our language, contains a large amount of original

matter on the development of the cells of plants, and the phenomena of reproduction, more especially amongst the lowest forms of plants. Between the publication of these two works, he devoted the larger portion of his time to microscopic observations, and he published several papers on these subjects in the 'Transactions of the Linnean Society,' the 'Annals and Magazine of Natural History,' and in the Reports of the British Association. The subject to which he gave the largest share of his attention was the nature of the changes which go on during the process of the impregnation of the ovule in the Phanerogamia. Schleiden had opposed the view of Amici, that the embryo is developed from an "embryonic vesicle" contained within the "sac of the embryo," and maintained that it was formed within the pollen-tube. Henfrey, from an early period, maintained the correctness of the first view of Amici, and made a great number of observations on the subject. The whole of that part of Professor Henfrey's work devoted to the histology and reproduction of plants is well deserving the study of those engaged in the microscopic investigation of the structure and formation of plants. Mr. Henfrey contributed two papers to the Transactions of our Society—one in the fourth volume of the new series, "On some Fresh-water Confervoid Algæ new to Great Britain;" and one in the seventh volume, "On Chlorosphæra, a new genus of Unicellular Fresh-water Algæ." It was in such papers as these that he displayed his careful habits of observation with the microscope; and had his life been spared, we might have expected from him large contributions to our present knowledge of microscopic organisms. During the last five years of his life he was occupied, in conjunction with Dr. Griffiths, in the laborious task of compiling and editing the 'Micrographic Dictionary.' Mr. Henfrey undertook the whole of that part of the work which related to the microscopic structure of plants. The value attached to this great work was indicated by the speedy demand for a new edition, which was completed just previous to the death of Mr. Henfrey. We have here treasured up all that had been done for the advance of botanical science by the aid of the microscope; and our friend could hardly have left behind him a more fitting monument of his industry and appreciation of microscopic inquiry, than his own contributious to this comprehensive volume.

But besides these labours having more especial reference to our specialty, Mr. Henfrey produced many other valuable works. In 1852, he wrote a volume on 'The Vegetation of Europe,' being an account of the distribution of the princi-

pal forms of plants found in Europe. The geography of plants found in him an able exponent, and he constructed the maps and wrote the letterpress on the distribution of plants, in 'Johnston's Physical Atlas.' He also further contributed to make this subject popularly understood, by translating from the German, Professor Schouw's 'Earth, Plants, and Man.' His acquaintance with German botanical literature was extensive, and he translated into English Schleiden's 'Lectures on the Biography of Plants,' and Alexander Braun's 'Rejuvenescence in Nature,' a somewhat speculative but interesting volume, published by the Ray Society.

Although he had not the gift of free speech, his earnest desire to impart all he knew, rendered him a popular teacher in his class; and when the late Professor Edward Forbes resigned his chair at King's College, he was appointed Professor of Botany in his place. Besides being a member of our own Society, he was a Fellow of the Royal and Linnean Societies, and had the appointment of Examiner in Natural Science at the Royal Military Academy at Woolwich, and at the Society of Arts. He was of a retiring and amiable disposition, and sincerely beloved by all those who knew him in private life. He fought a brave fight, and is a bright example of what a firm will can do amidst the feebleness of habitual indisposition.

In Mr. Andrew Ross the Society has lost one of its original members, and one who has had no little share in bringing the microscope to its present perfect state. He was an optician by profession, and laboured with Pritchard, Goring, Holland, and others, to bring the simple microscope to perfection, before Mr. Lister had made his great discovery of a combination of achromatic glasses in a compound arrangement. Mr. Ross was one of the earliest makers who comprehended Mr. Lister's principles, and carried them into practice in the manufacture of compound achromatic instruments. The perfect success, however, of these glasses was attended with a defect which in some measure was a drawback to their usefulness. This arose from their use in the examination of objects covered with thin plates of talc or glass, as the corrections for uncovered objects were found erroneous for those which were covered. Mr. Ross discovered the means of correcting this defect, which consisted in separating the anterior lens of the combination from the other two, in such a way that it could be brought further or nearer to them, according to the necessity of the case. An account of this discovery and its application will be found in the fifty-first volume of the 'Transaction of the Society of Arts,' pub-

lished in 1837. This method of correcting for covered and uncovered objects is applied to all our better object-glasses, and has since received some improvements at the suggestion of Mr. Powell. Mr. Ross has also from time to time added improvements to the general structure of the compound microscope, and suggested a variety of modifications in its accessory apparatus. If we are more indebted to him for his practical talent as a mechanician, it was not because he had not the ability to contribute to the literature of his profession. We have, in fact, from his pen one of the best articles that ever appeared on the microscope. This article was contributed to the 'Penny Cyclopædia,' in 1839, and is more or less the foundation of most practical treatises written since that time. Besides this masterly article, and the paper already referred to, I am not aware that Mr. Ross has contributed anything to the literature of the microscope; but these must ever give him a place amongst those who associated with Joseph Jackson Lister, and assisted to make the compound achromatic microscope the great instrument of research it is at the present day.

Those who have been in the habit of attending the scientific societies of the metropolis during the last twenty years will all recollect the intelligent and benignant face of the late Mr. Richard Taylor. Although for the last few years he had withdrawn from the activity of London life, his decease did not take place till the beginning of last year, and he continued a member with us till his end. Mr. Taylor was not so well known as a man of science, as he was as a man of letters who sympathised with men of science. He was a scholar, and cultivated that class of literature which led him to regard with especial interest the progress of natural science. He was especially associated with those who cultivated natural history, and was for many years a joint editor, as well as printer and publisher of the 'Annals and Magazine of Natural History.' He also edited four volumes of Scientific Memoirs, which were published by him from 1838 to 1846, containing translations of valuable scientific papers from the French and German. He was also, in conjunction with the late Mr. Richard Phillips, the editor of the 'Philosophical Magazine,' from 1827 to 1832. These varied labours in connection with the literature of science, constitute for him a strong claim to our remembrance and gratitude. His connection with the Linnean Society was more close than with any other, and he acted for many years as the Assistant Secretary of that Society.

The death of Mr. Furze is one that must have caused great

pain and surprise to many of the members. He was a man in the prime of life, and carrying on a large and successful business; but in the midst of all he found time to cultivate a taste for microscopic research. Without contributing to our Transactions, he took a great interest in our proceedings; and the intelligence and energy with which he cultivated the microscope, as an instrument of research, must have done much to recommend its use amongst a large circle of his friends and acquaintance. I accidentally had a proof of this some years ago, when visiting a village by the sea-side, in the county of Suffolk, where I found Mr. Furze had been staying for a few weeks before I had arrived. I had not long been there before I heard of the impression he had produced on the minds of the villagers by his daily demonstrations, upon the sea-shore, of the microscopic structure of the creatures with which the coast abounded. I have often thought that this would form the subject for a picture to a painter of the nineteenth century—a naturalist exhibiting the wonders of animal structure through a microscope to a rural population. By such pictures the great history of our civilization might be told.

Mr. E. Speer, though not a contributor to our Transactions, was deeply impressed with the value of the microscope as an instrument of research; and, in the hope of alleviating human distress by its agency, presented, before his death, a magnificent instrument, made by James Smith, to the Hospital for Consumption and Diseases of the Chest.

I would now call your attention to the state of our library. Since I addressed you last year, several works have been purchased, and others have been presented; so that we have altogether 186 complete volumes, with about 140 pamphlets and papers of various kinds. Although the number of books is not large, they present a tolerably complete epitome of the literature of the microscope in our own language. A catalogue of those works has been prepared by the Library Committee, and was published in the Transactions for the past year; separate copies have also been printed for the use of the members. A glance at this catalogue reveals to us the curious fact that the literature of the microscope has had two distinct periods; the first period may be said to commence with the establishment of the Royal Society, in 1660. From this time to the latter end of the eighteenth century, the 'Philosophical Transactions' abound with papers and memoirs devoted to the structure of the microscope and observations by its aid; and it is on this account that I think it would be most desirable that the members of this Society

should have the opportunity of consulting these precious volumes in our own library. The works that were the result of this activity are, I believe, tolerably completely represented in our catalogue. The first to which I would call your attention is the 'Micrographia' of Robert Hooke, published in 1665, and which, considering that it was the first work devoted to the literature of the microscope, is a perfect marvel. Its illustrations and the sound observations of the author may be studied with advantage at the present day. This was followed by the works of Grew and Malpighi on the Anatomy of Plants. Although Malpighi was a foreigner, his works were published by the Royal Society of London; they consisted mostly of papers which had appeared in the 'Philosophical Transactions.' He was the first to observe the passage of the blood through the capillary vessels, and his works otherwise abound with sound observations. In 1675 the communications of another distinguished foreigner commenced in the 'Philosophical Transactions;' and we may claim Leeuwenhoek almost as an English writer. His collected works will be found in our library, and contain an astonishing variety of observations on animal and vegetable structure. During this century Swammerdam wrote his treatises on insects, and made many curious observations with the microscope on the generation of the frog and other animals.

These researches bring us over the seventeenth, and carry us on to the commencement of the eighteenth century. Here we meet with the investigations of Trembley, on the Hydra; of Lyonet, on the Caterpillar of the Goat-moth; and of Spallanzani, on a variety of subjects. The latter was the first to maintain the independent animal nature of the Infusoria, and contributed a large number of observations on the function of animal impregnation. The works of Baker and the two Adamses close the labours, as far as our library will indicate them, of the eighteenth century, on microscopic subjects.

If we now turn over the pages of our catalogue, we in vain look for the continued activity of the preceding period. Observers seemed to think the microscope had done all for science that could be accomplished by its aid. It is true, the instrument was not forgotten. There were those who believed, if its powers could be increased, much more might be done by its aid. Brewster, Pritchard, Goring, Tulley, and others, worked at the construction of lenses, in the faith that more might be accomplished by its aid than had hitherto been supposed. Here and there observers were working unnoticed. Robert Brown was laying the foundation of the science of

Histology and the laws of development in relation to the vegetable kingdom, and Ehrenberg was studying the forms of infusorial animalcules in every part of the world. It was not, however, till the production of Mr. Lister's paper in the 'Philosophical Transactions,' in 1828, that a new impetus was given to microscopical research, and a literature sprung up unrivalled in the past history of the microscope. It would be impossible for me here to attempt to analyse this literature. It includes investigations with the microscope in every branch of natural science. It contains observations on the forms of crystals, plants, and animals; it embraces the highest generalisations of physiological science, and includes countless investigations into the origin, forms, and modes of growth of organs and the ultimate parts of organs of both plants and animals. Altogether, it forms an assemblage of facts and reasonings the most imposing that has ever been presented to the human mind in the same space of time in the whole history of science. To increase the stock of this literature, to render it accessible to all inquirers, and to make it the means of educating future observers by the aid of this instrument, will, I hope, be one of the constant aims of this Society.

From the Library let us turn to the Museum. It seems to me, when we consider the little cost and facility of keeping microscopic objects, that the development of the Museum should be more an object of attention than it has ever yet been to the Society. The whole collection of objects amounts to six hundred and sixty-three, seventy-three of which have been added during the past year. If illustrated works are a source of instruction, and important as enabling one inquirer to understand the views of another, there can be no doubt that properly named specimens are of more importance. This is especially the case with the forms of minute animals and plants which are described from time to time by different authors. If collections of species named by authors could be obtained from those who have first described them, they would be of great value for reference in all time to come. When we consider that the number of specimens in our Museum is not so great as those offered in the lists of those who vend these objects, and that their maximum value is not twelve pounds, I would suggest that we should do one of two things—either abandon the idea of a collection altogether, or place it in a position more worthy the credit and dignity of the Society.

Let me now call your attention to the work of the Society during the past year. Having been hastily summoned to quit our apartments in Regent-street, at the beginning of the year, and not having a place to meet in at the commence-

ment of the session, the council have found it convenient to curtail the number of our meetings; so that during the past year we have held but seven meetings, including the *soirée* at the South Kensington Museum, and the annual meeting on the 16th of February. Perhaps I may be allowed to say a word or two, first, with regard to the *soirée*. From the circumstance of the council having determined to hold this annual gathering in the extensive rooms of the Museum at South Kensington, which were placed at their disposal by the Committee of Council on Education, it was one of the largest meetings of the kind that had ever been seen in the metropolis. About three thousand persons were present, and the display of microscopes, and their accessory apparatus, was such as had never been got together before. Upwards of three hundred microscopes, exhibiting all the forms and applications of the instrument, were displayed. Although this exhibition of the instrument, and the assemblage of so large a number of patrons, might, consistently with the objects of your Society, have been purchased by a considerable outlay of funds, it must be gratifying to you to hear that, by the judicious arrangements of your council and the liberality of individual members, this immense meeting has not only not entailed on your funds any loss, but that you have been gainers by it to a slight amount.

As the ordinary meeting-nights of the past year have been only six, including the first meeting of this year, you will not be surprised to learn that only ten papers have been read.

The first paper was by Dr. Bowerbank, "On the Organization of *Grantia ciliata*," and contained a more detailed account of the structure of this curious member of the sponge family than had hitherto been published. To Dr. Bowerbank belongs the credit of having studied this interesting family of organized beings in the most exhaustive manner; and it will be gratifying to all present to know that he is now preparing a complete monograph of the British forms of sponges, which will be published by the Ray Society for the year 1861.

Our next paper was one "On Diatomaceæ collected in the United States," by Arthur M. Edwards, Esq. Besides this paper from the other side of the Atlantic, we have had another read, "On Diatomaceæ found near Gambia, Ohio," by Professor Hamilton L. Smith. These papers are interesting, as giving an account of the distribution of the Diatomaceæ in the New World, and they have been received by our Society as a gratifying proof that our aims and objects are reciprocated and understood by scientific inquirers in America. Dr.

Greville, of Edinburgh, has communicated a paper describing several new forms of the beautiful Diatomaceous genus *Campylodiscus*. Mr. Roper, in a paper on *Triceratium arcticum*, has shown that this genus must no longer be regarded as a non-catenated form of Diatomaceæ, as in its natural state its triangular frustules are connected together as in many other forms of this family. The last contribution on Diatomaceæ is by Dr. Wallich, who, in his paper "On the Siliceous Organisms found in the Digestive Cavity of Salpæ, and their relation to the Flint Nodules of the Chalk Formation," has endeavoured to account for the presence of forms of Diatomaceæ and Desmideæ in the flints and siliceous nodules of the chalk, by their having been collected by Salpæ in their stomachs, then swallowed by whales or other large animals, and, on the death of these creatures, been deposited in the bed of the ocean, in the concretionary form in which they are now found.

We may learn from these papers how great an interest attaches to the study of the Diatomaceæ, and how some of the highest problems in the history of the life upon our globe may be solved by their study. Formed of imperishable material, and, once formed, not experiencing the decay which is the law of every other existing organism, these minute beings leave behind them the most extensive record of their existence. Not only can we examine their forms, many of which are exquisite from their graceful outline and delicate carving, but even with regard to extinct species, we may gather the history of their habits and mode of increase, and other points, from the localities in which they are found. Independent, however, of the interest which attaches to the study of the Diatomaceæ as a group of organized beings presenting us, as it were, with the first struggles of life against the physical and chemical forces of brute matter, they are capital objects with which to train the eye and mind to habits of correct observation. It is in this group of beings that the advanced microscopist seeks for the severest tests with which to try the highest powers of his object-glasses; and it is in the observation of the forms and markings of these the most delicate productions of the Creative Hand that the young microscopist will best acquire the habit of distinguishing minute differences and resemblances.

An interesting communication was read at our June meeting, from Mr. George F. Pollock, containing "Observations on Granulated Blood Discs." This paper indicates that, however well the blood-discs may have been observed,

they still present phenomena whose full significance is not yet understood, and await for their explanation further observation and reflection.

The last paper read at our meetings, and not yet published in our Transactions, was one by Mr. Druce, "On the Reproductive Process in the Confervoideæ." In this paper Mr. Druce shows that there is yet much more to be done in making out the true reproductive process in Confervoideæ. He agrees with previous authors in the conviction that the process of conjugation in this family is not necessarily indicative of a union of germ-cells and sperm-cells; and certainly in most cases of conjugation this fact has not been made out. It is not at all inconsistent with our present knowledge of the ordinary function of vegetative reproduction by the multiplication of similar cells, which I have elsewhere ventured to call "homogenesis,"* that it should assume the forms and external phenomena of true generation (heterogenesis). We see this occurring in the fact that seeds which have originated quite independent of the influence of the sperm-cell occur in many of the higher forms of plants, and that ova and viviparous spores, as in the case of the bees and aphides, are produced under the same circumstances. It is, then, an interesting field for the microscopist, to study those lower forms of vegetable life in order to ascertain what phenomena are connected with the vegetative cell multiplication or homogenetic development, and what are the forms in which the phenomena of heterogenesis are presented to us.

These are the principal subjects which have been presented for microscopic inquiry during the year. In addition to these papers, we have had two on improvements in the structure of the microscope. One of these was by Mr. Richard Beck, "On the Universal Screw." Although Mr. Beck's paper pointed out some defects in the working of the plan for obtaining a universal screw, by which the object-glasses of different makers might be used by the same body, as carried out by a committee of our Society, it is very gratifying for us to know that, generally speaking, our plan has been most successful, and that microscopists, both in this country and America, recognise the suggestions of the Society as a great boon. The other paper on the instrument was by Mr. James Smith, who, in his description of a section and mounting instrument, with other contributions which he has made to the Society, has displayed considerable skill in the invention

* Preface to translation of Küchenmeister on 'Animal and Vegetable Parasites.'

of apparatus for microscopic investigation; and should he continue to apply himself to this department of study, there can be no doubt that the microscopic inquirer will be indebted to him for further improvements in the mechanical arrangements of the microscope.

But the labours of our Society do not end here. You must not forget that the 'Journal' originated in your Society, and has been conducted under its auspices, and that the papers published in its pages are as much a part of your organization as the papers published in your 'Transactions.' For the very reason that the papers in your 'Transactions' have been less in number, those in the 'Journal' have been more, and in no year since its origin has the 'Journal' been more rich in original papers than during the past year. These papers have been eighteen in number, besides translations and a variety of communications in the form of notes and memoranda. No less than ten of these have been on the Diatomaceæ; and although some may regard this as a disproportionate space for one set of objects to occupy, it must be remembered that these organisms are exclusively microscopical, and that at the present moment they possess for the microscopist a high interest, for reasons which I have before stated.

Two of the remaining papers, by Mr. Rainey, deserve your especial attention; one "On Dental Tissue," the other "On the Starch Granule." The object of Mr. Rainey in these papers is to show that the formation of the dental tissues, as well as of the starch granule, are due to the same process as that which he has so ably shown to take place in the production of shell and other hard parts, in his work on 'The Mode of Formation of Shells of Animals,' &c. As long ago as 1840 and 1841, Harting and Link published separate treatises* on the Production of Membranes, as the result of a process of crystallization of inorganic substances in contact with organic matters; and from time to time the presence of the aggregating force of crystallization has been alluded to, as possibly modifying the results of that action which has been called cell-force. It is, however, to Mr. Rainey that we are indebted for a full investigation of this subject; and he has shown that in all cases where a considerable quantity of inorganic matter is present, as in the case of carbonate of lime in shells, and phosphate of lime in bones and teeth, that the peculiar form of the tissue is due to the properties of the inorganic matter present. In his paper "On the Starch Granule," he has car-

* See Report on Botany, of Ray Society, 1845, pp. 6, 7.

ried this view further, and endeavoured to show that the peculiar form and structure of grains of starch are due to minute quantities of inorganic matter. For this process he has adopted the term "molecular coalescence." These observations are interesting in connection with the views of those who are opposed to the cell-theory of Schleiden and Schwann, and who prefer to speak of the whole of the phenomena of the formation of the tissues of plants and animals as a process of "differentiation." In connection with this subject, a paper by Professor Williamson, in the last October number of the 'Journal,' 'On some Histological Features of the Shells of Crustacea,' is well deserving attention. He there shows that certain tissues in the shells of the Crustacea that had been regarded as cellular in their structure, are produced in a protoplasmic matter, independent of cells or nuclei. I will not, however, enter here further into the matter, but call your attention to this subject as a field inviting further inquiry, and likely to yield abundant fruits to those who have leisure and opportunity for its culture.

To Mr. Currey the pages of our 'Journal' are largely indebted for his varied contributions in the field of mycology. His 'Mycological Notes,' in the number of the 'Journal' for July, is an example of how various observations on the same series of objects may be communicated with great advantage to those who are working in the same direction. In these busy days, when so many observers are investigating the same subjects, it becomes a matter of importance to all to know what others are doing, so that no time may be wasted in re-discovering what others have done. In connection with the subject of mycology, I may also draw attention to a translation in the last number of the 'Journal,' in which M. De Bary attempts to show that a certain group of the Fungi are rather of an animal than of a vegetable nature. Although considerable doubts may be thrown on M. De Bary's conclusions, his observations indicate the interest that still attaches to the question of the limits between the animal and the vegetable kingdoms. It is only by the aid of the microscope, used by well-trained observers, that such a question can be decided; and large groups of forms belonging to the Protophyta and Protozoa present themselves for investigation on this subject. Here, too, is a district in which perhaps the inquiries of the microscopist may come in to assist the inquiry which has just been opened by one of our most distinguished naturalists as to the origin of species.* It is only

* On the 'Origin of Species,' by Charles Darwin, F.R.S.

by the microscopical observer that the question of the spontaneous generation of animals and plants can be set at rest. As far as the results of present investigation go, there seems to be no satisfactory evidence that the organisms which we call plants and animals have had any other origin than organisms endowed with vital properties similar to themselves; but as to how far any one of these organisms may differ from its predecessors through all time, we are in the dark. At first sight, it looks as if this question of the origin of species was one that must be for ever veiled from our sight; and if it had not been raised by an inquirer so competent to judge of the possibilities of our science, we might have passed by the challenge unheeded. But we have been invited to ascertain the amount of change of which each individual organism is capable, and especially to observe how far such changes impress themselves permanently on the organisms, or series of organisms, in which it takes place. If by the collation of past well-observed facts with those which present themselves before us at the present day, and allowing the largest amount of time that can be reasonably demanded, we come to the conclusion that the higher organisms could be degraded to the forms of the microscopic Protophyta or Protozoa, or that these latter could be elevated to the condition of vertebrate animals, then we ought perhaps to conclude, with Mr. Darwin, that probably all organisms are derived from a single prototype. But if, on the other hand, the amount of change we can observe either of degradation or elevation, or both, is so limited that no amount of time could account for the diversity of forms of animal and vegetable life we see around us, I think we are driven back upon the hypothesis of a special creation of species, without being committed to the special form or manner of that creation. But, whatever be the direction in which our opinions lead us, let us not be hasty in the interpretation of the facts which are presented to us. Let us observe carefully and cautiously, and record our observations faithfully, in the full confidence that the Creator has so endowed the human mind, that it will in the end reject all that which is false, and only hold that which is true.

I now call your attention to two papers of high interest, on the microscopic structure of the nervous system; the one by Messrs. Turner and Lister, of Edinburgh, the other by Mr. Lockhart Clarke, of London. To the latter gentleman we are indebted for our knowledge of a method of preparing nervous tissue for examination, which has resulted in a much more accurate knowledge of the details of the structure of the

nerve tubes and cells than has been hitherto known. I need not tell you, perhaps, that there is yet much to be learned with regard to the functions of the nervous system; and that, whatever advances the physiologist may make in this direction, the real relation between function and structure will only be made by the microscope. Here, then, is a subject for some of our younger friends to pursue. The fact is, in whatever direction we turn our eyes, there is still work to be done; and I have often thought it would be possible for this Society to imitate the proceedings of the great French Academy, and appoint committees to report on researches or on subjects demanding research, which would give an impetus and direction to an amount of activity and energy that is now too often unproductive. It has been the reproach of our country that, whilst undoubtedly we have the finest instruments in the world, our contributions to micrological science are not at all in accordance with our superior opportunities of observation. I hope our Society, as it increases in numbers, will do more and more to wipe away this reproach. I hope to see our 'Transactions' increasingly enriched by papers that will bear the stamp of the excellence of our instruments upon them, and that the pages of our 'Journal' will have diminishing space for foreign contributions, on account of the value of those from our home market.

In my address last year, I brought before you the subject of the desirability of rendering the microscope available in our natural history and other museums. No one knows better than you that he who sees with his naked eye alone sees but half the world that God has made. With this impression, I suggested the manufacture of a museum microscope on a plan that I find was not at all new, and which has been now at work in the South Kensington Museum for nearly twelve months. It has so far answered its purpose that, whilst thousands have looked at the objects to be seen by its aid, the instrument has not suffered in its arrangements; and the Committee of Council on Education have ordered four of them to be placed in various parts of the Animal Product and Food collections at the South Kensington Museum, for the exhibition of objects which cannot be seen by the naked eye. The only way to gain for society the full advantages of science is to bring the popular mind, by education, into a condition in which it can comprehend the principles involved in the application of its truths in the manifold directions of art, industry, and health. The discoveries of science lose the higher part of their value, unless they become appreciated and applied by an educated public. It is for

societies like ours to encourage the extension of scientific education, to enlist the neophyte in our ranks, and thus to secure accomplished observers and discoverers, and a public capable of comprehending and applying their discoveries.

I have thus endeavoured to glance at the work of the year, and embody the thoughts it suggests; but before I close, I would remind you of the obligation we are under to the Council of the noble Institution within whose walls we have permission to meet. When obliged to leave our apartments in Regent Street, at the latter end of our last session, we obtained the consent of the Council of the Royal Society, and the Senate of the University of London, to meet in the large room which they now jointly occupy. We had hoped that this permission would have been permanent, and I feel it due to the Senate of the London University to say that, as far as they were concerned, such permission was granted; but the Council of the Royal Society could not see its way clear to give up its rooms for our use once a month; and thus we were compelled to look for a meeting-room in some other direction. It was then suggested by Dr. Lionel Beale that application should be made to the Council for permission to meet in the rooms of King's College; and I can bear testimony to the promptitude with which this request was responded to, and you yourselves are the witnesses of the readiness with which all the accommodation we require has been accorded to us. I am also able to state that the Council of this College has, with the same generosity, placed the whole suite of rooms at the disposal of the Society for a soirée on the 11th of April next.

It now remains for me to offer thanks for the courtesy that I have received on all hands, and for the kind manner in which I have been assisted by the Council, and supported by you, in performing the duties of your President. It gives me great pleasure to resign this chair to one who is so well entitled to fill it, and whose election is so honorable to the Society itself. Professor Quekett has worked with us from the beginning, and much of the success of the Society has depended upon his exertions. Many of the most valuable papers in our 'Transactions' are the result of his pains-taking and accurate habits of observation, and he has been our Secretary for nineteen years. These labours alone would have entitled him, at your hands, to the position in which you have this day placed him. But independent of what he has done for you, as Professor of Histology in the Royal College of Surgeons of England, as the author of the masterly lectures which he has delivered from the chair he holds, and as the

first and ablest historian of the microscope, its structure and uses, he has pre-eminent claims to be the President of the Microscopical Society of London. To this post he would long ago have been elected, had your wishes alone been consulted; but his devotion to science has entailed upon him one of its too frequent accompaniments, and that is ill health; and this alone is the plea that he has put in against your wish to make him your President on this occasion. I am sure you will join me in wishing that he may be speedily restored to good health and strength, and that he may never be deterred from occupying your Presidential chair by the presence of those bodily infirmities which accompany disease.

The Society then proceeded to ballot for officers and four members of Council in the usual manner, when the scrutineers having made their report, the following were declared duly elected:

President—Professor QUEKETT. *Treasurer*—N. B. WARD, Esq. *Secretaries*—G. E. BLENKINS, Esq.; M. S. LEGG, Esq.

Four Members of Council—Dr. MILLAR; J. R. MUMMERY, Esq.; Dr. WALLICH; S. C. WHITBREAD, Esq.;—in the place of A. BRADY, Esq.; J. GLAISHER, Esq.; H. PERIGAL, Jun., Esq.; J. H. ROBERTS, Esq.; who retire in accordance with the regulations of the Society.

The thanks of the meeting were unanimously voted to Dr. Lankester, for his services as President during the past two years.

On the AMŒBOID CONDITIONS *of* VOLVOX GLOBATOR.

By J. BRAXTON HICKS, M.D., Lond. F.L.S., &c.

(Read March 14th, 1860.)

THE effect of the attention paid of late to the histology of the lower tribes both of the animal and the vegetable kingdom has been to lessen the number not only of species, but of whole groups, and to rob zoology of many of its subjects. Perhaps this is best shown in the case of the zoospores,

where whole genera of Monadina, Astasiæa, &c., have been distinctly proved to represent only one of the many phases of the respective Algæ to which they belong. But that *Amœba*—the moving and all-devouring "sarcode"—and *Actinophrys* with its extemporised tentacles, possessing some of the very essentials of animal life, should belong to the vegetable kingdom was scarcely to be expected.

Still we have now on record the results of the careful observations of *three* naturalists, which seem to prove that an Amœboid phase occurs in the life of many vegetables.

Dr. Hartig* has noticed that the antheridia of *Characeæ*, *Polytrichum*, and *Marchantia*, change into *Spirillum*, *Vibriones*, and *Monas* consecutively; and that from the fusion together of a number of these last, bodies are formed undistinguishable from *Amœba princeps*. He remarks that, by some means or other, Diatomaceæ find their way into the interior of this self-moving mass, within which they circulate in obedience to the various currents.

Mr. Carter† has watched the changes in the protoplasmic contents of the cells in *Spirogyra*, both conjugating and agamic, from which rhizopodous bodies are produced, some like *Amœbæ*, others becoming precisely similar, in appearance at least, to *Actinophrys sol*.

Dr. De Bary, as noticed in the Journal (vol. viii, p. 97), has lately remarked, in his examination of the Myxogastres, that the creeping threads of mucilaginous matter, by the confluence of which the fructifying mass of *Æthalium* is formed, consist of *Sarcode*. He also remarks, that the spores placed in water burst, and their contents escape, clothed only by a very thin primordial utricle, and furnished with cilia. These bodies progress as ordinary zoospores, and by further changes are converted into organisms precisely like *Amœbæ*, from which, eventually, spore-cases are formed. De Bary, therefore, concludes that the Myxogastres are not fungi, but animals (allied to Rhizopods), and calls them "MYCETOZOA."

A *fourth instance* of this phenomenon occurred to myself in the course of some observations on *Volvox*, six years since, at the end of the summer, at the time when *Volvox globator* was changing into *V. aureus*; although the appearances I allude to were noticed in *V. globator*, in its ordinary form, and in *two* stages of its existence.

The *first* example in which I observed motion in the cell was

* See 'Journ. of Micros. Science,' 1856, p. 51.
† See 'Annals of Nat. Hist.,' 1857, p. 259.

at an early period, before the young *Volvox* is fully grown, at the time when the future zoospores first appear, enclosed in cells, the final product of segmentation. These zoospore-containing cells, by contact with their neighbours, are rendered multangular, and they include about twenty or thirty hexagonal, young zoospores, in close contact, and which are of many colours, as shown at Pl. VI, fig. 12, *a*, *b*. When these cells are detached, they become round, and, (to quote my notes at the time, "They have a curious power of changing shape, like an infusorial *Proteus*, protruding the wall, first at one side, and then at another, into which protrusions the contents run" (fig. 12 *c*). The other and more striking instance, however, was visible in the zoospores themselves at an advanced age, when some of them enlarge and become irregular in outline (Fig. 13 *a*). Some disappear. Some break up and disperse within the *Volvox* (sperm-cells?). Some undergo a process of subdivision (germ-cells?), producing a group of from two to forty green drops, arranged so that their apices, with cilia, point externally; while others enlarge to two or three times their natural size, having many nuclei within, and variously coloured. When this cell, probably by the solution of the outer mucilaginous coat, becomes free, it also possesses the power of moving precisely as does a true *Amœba*. Unfortunately, I did not extend my observations so far as to see if in its progress it included foreign matter,—a point of much interest; the conditions, however, above described were so distinct, that there was no possibility of mistake by confusion with other structures, as I watched these aged zoospores move away in many instances from their original position, while it underwent the transition.

To conclude, with Dr. De Bary, that the Myxogastres are animals, because in some phase of their existence they possess a self-moving endoplast, seems in our present knowledge to be premature; for then must we include the above-mentioned genera, not excepting *Volvox* and its congeners in the animal kingdom,—a step for which botanists are not as yet prepared. A much better explanation seems to me to be this: that the protoplasmic contents, when deprived of their confining envelope of cellulose, possess, in common with Sarcode, under certain circumstances, a power of spontaneous motion in the manner of an *Amœba*. It is questionable how far such actions in the Rhizopodan class are the result of any true consciousness, or whether it is not an involuntary action—a property which can scarcely be denied to vegetables composed only of endo- or protoplast; and this would seem to be strengthened by the fact I have observed, viz., that before protrusion, in the *Amœba*

and Amœboid bodies, takes place, a rush of the semi-fluid contents to the spot can be plainly seen before any bulging occurs. Whether these Amœboid bodies possess the power of "eating," will be a question for future observation.

The above remarks increase the interest connected with the life-history of *Volvox globator*, which from analogy we may suppose to be a zoospore-state of another existence; to which opinion, indeed, the results of investigations are gradually drawing us.

A Monograph of the Genus ASTEROLAMPRA, *including* ASTEROMPHALUS *and* SPATANGIDIUM. By R. K. GREVILLE, LL.D., F.R.S.E., &c.

(Communicated by F. C. S. Roper, Esq., F.L.S., &c. Read March 14th, 1860.)

SINCE the publication of my paper on Diatomaceæ occurring in Californian guano ('Mic. Journ.' vol. vii), some very interesting materials have been placed in my hands, the careful study of which has led me to take a different view than I formerly entertained, of the generic relations of *Asterolampra*, *Asteromphalus*, and *Spatangidium*. The materials referred to consist of—1. Soundings from the Indian Ocean, obtained by Captain Pullen, in latitude 5° 37′ south, and longitude 61° 33′ east, at a depth of 2200 fathoms. This most remarkable gathering was presented by Mr. Hilton to Mr. Roper, who very kindly transmitted a portion of it to myself. 2. A series of slides prepared from some of the deposits of the United States, by Mr. E. W. Dallas. 3. A series of slides prepared by Professor Walker-Arnott, from the substance known under the name of Monterey stone.

My investigations into the great variety of allied forms derived from these sources point very decidedly towards a union of the three genera above mentioned; and that *Asteromphalus* and *Spatangidium* will most naturally take their place as sections under *Asterolampra*. I may here candidly admit that, soon after the publication of my former paper, I became convinced that I had committed an error in adopting, under any modification, the genus *Spatangidium;* an error which might be traced to my desire to retain, if possible, a genus established by so distinguished a naturalist as De Brébisson. For although at first sight, under a moderate power of the microscope, the difference was so striking as to

justify De Brébisson in using the terms celluloso-reticulate, subpunctulate, subgranulate, &c., in order to describe the relative appearance of the segments under the same magnifying power, it was easy to see by sufficiently increasing the power that the structure of all was essentially the same.

In the preparation of the present communication, I gladly acknowledge the valuable suggestions I have received from my friends, Professor Walker-Arnott and Mr. Roper.

As some confusion already exists with regard to the names applicable to the different parts of these discs, it is desirable that some attempt should be made to regulate them. I venture, therefore, to propose the following nomenclature, which will be followed in this paper, and easily understood with the help of the following diagram:

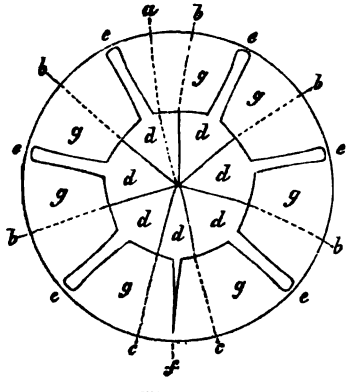


Fig. 1.

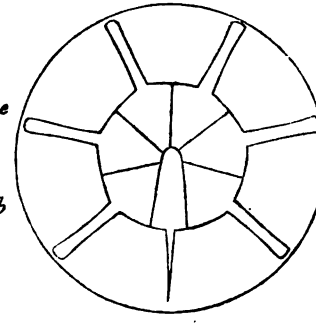


Fig. 2.

Fig. 1, diagram of *Asteromphalus;* Fig. 2, diagram of *Spatangidium.* To convert Fig. 1 into a diagram of *Asterolampra,* all that is required is to separate the lines *cc* a little, and make the ray *f* as broad as the rest.

a umbilicus, *b* umbilical lines, *c* median lines (approximated umbilical lines), *d* hyaline area (composed of the united bases of all the rays), *e* rays, *f* median ray, *g* areolated segments.

A few explanatory remarks may be required with reference to some of these terms. It has been suggested that "hyaline area" is uncalled for, because it is composed merely of the bases of the rays. This is true, but it is composed of the bases of the rays *collectively*, and it will be very convenient sometimes to be able to define the contour, position, &c., of this area. As to the rays themselves, there can be no doubt

that it is desirable to restrict the appellation to those radiating divisions which, commencing at the umbilicus, are at first included between the umbilical lines and are afterwards continued in a contracted and linear form between the areolated segments to the margin. The umbilical lines ("sepimenta imperfecta," of Ehrenberg) offer greater facilities for description than the bases of the rays themselves, and a name for them could hardly be dispensed with.

Several terms have been suggested for the narrow or "obsolete" ray which occurs in *Asteromphalus* and *Spatangidium*; but, upon the whole, I prefer that of "median," which is as expressive as any of the others, and has the advantage of having been already used by De Brébisson. An additional recommendation is, that it enables me to apply the equally expressive term, "median lines," to the two approximated lines above the median ray, there being evidently some connection between these parts. The position of these lines differs in *Asteromphalus* and *Spatangidium*. In the former genus they appear as really umbilical lines, approximated indeed, but still springing, like the rest, from the central point. In the latter they do not do so, and therefore cannot strictly be called umbilical lines. In fact, they have no relation with the other lines in point of radiation. It was, therefore, desirable to invent a term which should be equally applicable in both genera. By the term median, then, I wish to imply the two lines which invariably accompany the median ray, and only exist in connection with it. We shall see that much interest attaches to these lines, and that they afford good discriminative characters.

Without giving the original characters *verbatim*, the three genera under consideration are distinguished as follows:

ASTEROLAMPRA, Ehrenb. in 'Berl. Monatsbericht,' 1844, p. 73. The valve is strictly circular, with a centrical hyaline area, which is equally divided by lines ("sepimenta") radiating from the umbilicus. Each of these lines terminates at the base of a marginal areolated segment, while alternating with them the rays are continued between the segments to the margin.

ASTEROMPHALUS, Ehrenb. in 'Berl. Monatsbericht,' 1844, p. 198. The valve is exactly circular, with a centrical hyaline area; but, instead of being equally divided by the lines ("sepimenta imperfecta") which radiate from the umbilicus, two of them are approximate and parallel; and instead of all the rays being equal, one of them is much narrower than the rest, or, as Ehrenberg calls it, "deficiens vel ita obsoletus."

SPATANGIDIUM, De Bréb. 'Bull. de la Soc. Linn. de Nor-

mandie,' 1857. The valve is "suborbicular," and the "point d'où rayonnent les ambulacres . . . . est toujours excentrique."

It will be perceived that if we take a frustule of *Asterolampra* (which may be assumed as the typical form of the group), and merely approximate two of the umbilical lines, so as to become parallel, and make the ray between them narrower than the rest, we have at once an *Asteromphalus*; and that between the latter genus and *Spatangidium* there is only (according to De Brébisson's view) the eccentrical position of the hyaline area, with its lines and rays. Again, if we take the genus *Asterolampra* as our stand-point, and examine in what respects Ehrenberg has made *Asteromphalus* to differ from it, we are reduced to the conclusion that the former rests its claim to generic distinction, as compared with the latter, on the sole circumstance that the rays and umbilical lines are all equal.

Let us now examine how far these genera have been affected by recent discoveries. In *Asterolampra* the species named *Marylandica* was the only one known to Ehrenberg; and though various others have been subsequently described, they must all be referred to that species. In all of them the areolated segments are concave at the base, and the umbilical lines straight and simple. But other species, very different in habit, must now be introduced on the claim specified in the close of the last paragraph. One of these is *Asteromphalus Grevillii*, of Wallich,* from the Indian Ocean, found also by Mr. Dallas in the Rappahannock deposit, United States, and by Professor Walker-Arnott in Monterey stone; in which the numerous segments are square at the base, and the umbilical lines are variously divided. In *A. variabilis*, another species found in the same material, the umbilical lines are most of them divided near to the central point, being either forked or arranged in triplets; while the base of the segments is so sharply angular as to give a triangular aspect to the adjoining portion of the rays.

In a third species from the same source (*A. Brébissoniana*, Pl. III, fig. 9), the numerous segments are square at the base, and the umbilical lines exhibit the angular bend in the middle, which is observable in certain species both of *Asteromphalus* and *Spatangidium*. It is impossible not to perceive how strongly the characters and natural habit of the diatoms noticed above run into those of the last-named genera.

Asteromphalus, as we have already seen, only differs (ac-

* 'Trans. Mic. Soc.,' vol. viii, p. 47, Pl. 2, fig. 15.

cording to Ehrenberg himself) from *Asterolampra* in two of the umbilical lines common to both genera becoming approximate and "parallel," and in one of the rays common to both genera becoming narrower than the rest. But even this difference is not strictly maintained in all Ehrenberg's own species; for in *A. Darwinii* and *A. Rossii* the median lines are not "parallel," but cuneate. This deviation from the generic character is still more prominent in recently discovered species, which, notwithstanding, cannot be excluded from this place. In my *Asterolampra Dallasiana*, for example (Pl. IV, fig. 10), the median lines are campanulate; and in my *Asterolampra Wallichiana* (fig. 11), they are so widely cuneate as to show a decided approach to *Asterolampra* as restricted by Ehrenberg. It is evident, therefore, that were the genus to be sustained, the character derived from the parallelism of these lines would have to be abandoned. With regard to the form of the segments, they are represented as concave at the base in all Ehrenberg's species. In *Asterolampra Dallasiana* and *A. Wallichiana*, however, they are square at the base. The angular bend in the umbilical lines which marks some species of *Asterolampra* and *Spatangidium* is found also in *Asteromphalus* in one or two instances.

I have remarked elsewhere—and am glad to see that my view is supported by Dr. Wallich—that the character on which De Brébisson founded his genus *Spatangidium*, viz., the eccentrical position of the hyaline area, is far too uncertain to be relied on; for valves are continually occurring in which this feature is scarcely, if at all, perceptible. And when this character disappears, so also does the "sub-orbicular" form of the valve. How little dependence can be placed upon it is well shown in *S. heptactis* of De Brébisson (*S. Ralfsianum* of Norman, in my former paper). De Brébisson does not state the form in his description, but his figure represents it as broadly ovate, whereas in mine it is the very reverse.* An exception, however, appears to exist in *Spatangidium Arachne*, which, as far as I have observed, retains constantly its round-ovate outline, as well as its highly eccentrical arrangement. A better generic character than the latter might have been found for *Spatangidium*, as Professor Walker-Arnott has suggested, in the median lines (Dr. Wallich's basal ray) passing over and beyond the central point, so as to cause the umbilical lines to radiate from the top and sides of the median lines, and not from the central point

* 'Mic. Journ.,' vol. vii, Pl. 7, fig. 8.

itself, as in *Asteromphalus*. A most remarkable species, however, belonging to the Indian Ocean soundings—my *Asterolampra Roperiana* (Pl. IV, fig. 14)—seems to form a connecting link, not only between these two genera, but including the *Asterolampra* of Ehrenberg itself. It will be seen at a glance that the plan, so to speak, of the valve is far more that of *Asteromphalus* than of *Spatangidium*. In the circular outline, in the centrical hyaline area, radiation of the umbilical lines, approximation of the median lines, and in the median ray, it is an *Asteromphalus*. In the single circumstance that the median lines pass slightly beyond the central point, forming a little imperfect circle round it, is the frustule, a *Spatangidium*. The median lines in this species present some additional curious features. But for the intervention of the little imperfect circle, which may be compared to the nave of a wheel, the umbilical lines would meet at precisely the central point. Immediately beneath the imperfect circle the median lines contract into a sort of neck, and then, instead of continuing to be approximate, as they ought to do for a *Spatangidium*, or parallel, as Ehrenberg would require of them for an *Asteromphalus*, they diverge, and by a curve reach the edge of the hyaline area at points almost equidistant between themselves and from the adjoining umbilical lines. In this last character (sub-equidistance of the *termination* of the median lines), as well as in the sub-equidistance of all the rays, the median one included, the frustule is very nearly an *Asterolampra*. The valve in my *Asterolampra Shadboltii* is also circular, and, but for the median lines passing slightly beyond the central point, would in every other respect belong to the *Asteromphalus* section. In *Asteromphalus Brookei*, likewise, of the late Professor Bailey, the valve, if not actually circular, appears to be so to the eye, and the median lines, which somewhat resemble those of *Asterolampra Roperiana*, scarcely pass beyond the central point. Enough has been said, perhaps, to illustrate the transition of these genera into each other; and we may now proceed, in accordance with the views advocated, to give a systematic arrangement of the known species.

ASTEROLAMPRA, *Ehrenb.*

ASTEROMPHALUS, Ehr. SPATANGIDIUM, De Bréb.

Frustules simple, two-valved, disciform. Valves orbicular or sub-orbicular (in one case oblong); central area hyaline, and furnished with radiating lines, each of which terminates at the base of an areolated marginal segment; while, alter-

nating with them, transparent rays are continued from the hyaline area between the segments to the margin.

SECTION I.—Rays equal and equidistant: ASTEROLAMPRA.

1. *Asterolampra Marylandica,* Ehr. Umbilical lines simple, straight; areolated segments curved at the base. Diameter ·0016″ to ·0080″. (Pl. III, figs. 1—4.)

Asterolampra Marylandica, Ehr. Berl. Monatsbericht, 1844, p. 76, Pl. (June), fig. 10. Bail. Sill. Journ., vol. xlviii, Pl. 4, fig. B. Kutz. Sp. Alg., p. 129. Pritch. Animalc., p. 320, Pl. 14, fig. 33. Mic. Dict., p. 71, Pl. 19, fig. 5. Wall. Trans. Mic. Soc., vol. viii, p. 47, Pl. 2, figs. 13 (6 rays), 14 (7 rays). Brightw. Mic. Journ., vol. viii, Pl. 5, fig. 3 (6 rays).

A. septenaria, A. S. Johns. Sill. Journ., 2d ser., vol. xiii, p. 33.

A. impar, Shadb. Trans. Mic. Soc., vol. ii, Pl. 1, fig. 14 (7 rays).

A. pelagica, Ehr. Berl. Monatsbericht (1854), p. 238. (Noticed first by Müller, Abhandl. d. Berl. Akad. 1841, vol. i, p. 232, Pl. 6, fig. 4, in his Memoir über den Bau des Pentacrinus caput Medusæ (7 rays).

Hab. Various deposits in the United States (6 to 9 rays). West Indies (7 rays), R. K. G. Natal (7 and 11 rays), Shadbolt. Monterey stone (7 rays), Professor Walker-Arnott. Indian Ocean, from *Salpæ* (6 and 7 rays), Wallich. Indian Ocean soundings, at 2200 fathoms (6 rays).

This species is exceedingly variable; and, notwithstanding the number of figures which have been given of it, several of which, however, are merely repetitions of each other, I have considered it very desirable to offer some additional ones, in order more fully to illustrate deviations from what may be regarded as the typical form, well represented by Ehrenberg's original figure. That author has assumed eight as the normal number of the rays, and he is probably correct with reference to the frustules found in the American deposits. I believe that number to predominate, although specimens with from six to nine rays also occur in the same deposits. It is at the same time a very curious fact, that in the Indian Ocean soundings every example which has come under my notice possesses only six rays; and Dr. Wallich has represented one, likewise with that number, obtained from *Salpæ* in the Bay of Bengal. While thus the number eight appears to predominate in the American deposits, and six in the Indian Ocean (so far as known), an odd number, seven or eleven, was found by Mr. Shadbolt to exist exclusively in a gathering from Port Natal. It would be rash from such limited data to conclude that these are the prevailing numbers on the coast of East Africa; still it is remarkable, that in the gathering specified,

with the frustules "moderately abundant," not one should have been observed having other than seven or eleven rays. The extreme range appears to be from six to twelve; Dr. Wallich refers to one in his possession, without mentioning the locality, containing the latter extraordinary number. It is, however, now admitted on all hands that the number of rays is of no diagnostic value whatever; and, consequently, it is necessary to bring together all those so-called species which have no other character to rest upon. Among the examples which I have given in Plate III, are frustules with six, seven, and nine rays; but I have not selected these forms on account of this variation, but in order to show how widely the valves may otherwise differ, and to assist in determining the question of identity. In fig. 1, from Piscataway, Maryland, the rays are not only numerous, but the segments form an extremely deep curve; and in Dr. Wallich's figure, 14, l. c., the same effect is produced with fewer rays, in consequence of the segments being carried still nearer to the umbilicus. In my figure 3, detected by Mr. Dallas in "Bermuda Tripoli," the species seems to have reached the very opposite extreme, and its most aberrant condition. The hyaline area is so large as to occupy half the radius; and the curve of the areolated segments is not only very shallow, but ceases to be regular, being considerably flattened; all which makes the rays appear so short, that they might be compared to the handles of a steering-wheel. I have introduced figure 2, from Rappahannock, to show that while the hyaline area occupies even a larger portion of the valve than the preceding, the segments preserve the true curve. The valve has seven rays, and presents a most striking contrast to Dr. Wallich's fig. 14, l. c. My fig. 4 represents a frustule from the Indian Ocean soundings, remarkable for its gigantic size. It exhibits also a peculiarity, observable in all the specimens, obtained from the same quarter,—a greater breadth of the ray than usual. The umbilical lines may be said to be normally simple in this species; but one or two of them are occasionally forked close to the central point, as seen in fig. 1.

With regard to the nature of these lines, it is improbable that they indicate an actual division or dissepiment between the bases of the rays, as such a provision would seem to be useless while the remaining portion of those organs is so firmly united to the adjoining parts. In the numerous fractured specimens of *Asterolampra* and *Spatangidium* I have examined, I have never been able to trace any disposition in the valve to break up in the direction of these lines. The more correct view, it appears to me, is that suggested by Mr.

Roper, viz., that they are raised and thickened lines, intended to strengthen the valve. In a frustule of *A. Marylandica*, to which he drew my attention as throwing some light on the subject, a portion of the hyaline area has been accidentally destroyed, leaving one of the lines denuded throughout its whole length. From its evident strength, it is admirably adapted to the purpose assigned to it by Mr. Roper. Indeed, the hyaline area, in all these diatoms, may not be unaptly compared to a circular window, with radiating bars, fitted with transparent siliceous panes. In several species of this and the following sections, there is an apparent thickening in the rays, especially where they pass the confines of the hyaline area. At this part there is sometimes a sort of ridge or convexity, which gradually subsides into the plane surface of the basal portion of the ray. This appearance is indicated in Mr. Shadbolt's figure already quoted, and is probably caused by an internal channel, the termination of which, near the umbilicus, is occasionally tolerably evident; but I do not find anything like the line passing down the *middle* of the ray, as faintly seen in Mr. Shadbolt's figure, and conspicuously in that given by Mr. Brightwell. ('Mic. Journ.,' vol. viii, pl. 5, fig. 3.) That the rays are tubular, seems to be confirmed by Dr. Wallich, who finds air-bubbles in them in some of his balsam-mounted slides. It is now well known, that the two valves of the frustules of this group do not correspond in the disposition of the rays, or, to use a printer's phrase, they do not register; but that the ray of one valve is opposite to the areolated segment of the other,—a circumstance which, to an inexperienced observer, is often not a little perplexing. This arrangement was first noticed by Müller, who, in fact, figured the two valves of *Asterolampra* in their normal position, before Ehrenberg himself constituted the genus. He remarks, "Dieser Stern ist eine Doppelfigur und besteht aus einem vordern und hintern stern, woven jeder 7 Strahlenhat, die Strahlen des hinteren stehen in den Zwischenräumen der Strahlen des vorderen."*

It is a curious fact, that in species where the umbilical lines are more or less branched, those of the two valves do not necessarily correspond. In a beautiful frustule in my possession, of *Asteromphalus Brookei* of Bailey, the upper valve is so convex that the umbilical lines can be focused distinctly from those of the lower flat valve, and it appears that the furcation of the two sets of lines is to some extent different. This tends to confirm Mr. Roper's idea above-

* Abhandl. d. Berl. Akad. (1841), vol. i, p. 232.

mentioned, that these lines are to be considered mainly as ribs or bars of support. No species has so wide a range with regard to size as *A. Marylandica*. The smallest that has come under my notice is a specimen belonging to Mr. Roper, of Shadbolt's *A. impar*, which is only ·0018″.

2. *Asterolampra Rotula*, n. sp. Grev.—Areolated segments nearly square at the base; umbilical lines simple, or forked close to the central point. Diameter ·0044″. (Pl. III, fig. 5.)

Hab.—Monterey stone, Professor Walker-Arnott.

It is with considerable hesitation that I venture to offer this diatom as distinct from the following, and should not have done so but for the opportunity afforded me by Professor Walker-Arnott, of inspecting a series of that species. I find, on a close examination, and after making drawings of a number of specimens, so uniform an adherence to the character furnished by the base of the segments, that I cannot at present bring myself to regard the present form as a variety. At the same time it may be held as only provisionally independent. The segments are somewhat square at the base, and the linear portion of the rays commences abruptly at the margin of the hyaline area; whereas, in the following species, the linear portion of the rays assumes a triangular figure before leaving the hyaline area, in consequence of the very different outline of the base of the segments. The umbilical lines of the two are much alike; those of the species under consideration showing a disposition to divide. It will be perceived that one of them, immediately after leaving the central point, separates into three branches.

3. *Asterolampra variabilis*, n. sp. Grev.—Areolated segments, with a dipping angle at the base; upper part of the basal portion of the ray triangular; umbilical lines simple, forked, or in triplets. Diameter ·0028″ to ·0048″ (Pl. III, figs. 6—8.)

Hab.—Monterey stone, Professor Walker-Arnott.

The most characteristic feature, as I conceive, of this diatom, arising from the form of the basal portion of the rays, and consequent angular base of the segments, has been referred to in my remarks on the preceding species. The result of this character is a very beautiful rosette-like contour of the hyaline area, and constant in all the specimens I have seen. The umbilical lines, also, are remarkable. In *A. Marylandica* they are, as we have seen, normally simple, being rarely (one or two only) forked. In the species now before us, the reverse is the case. In the great majority of instances the lines are forked or in threes; so that in the same valve there will seldom be more than two of them un-

divided. In the series already referred to, as communicated by Professor Walker-Arnott, the following arrangements of these lines occur. (1.) In a valve with seven rays, one line is simple, six united in triplets; so that only three lines actually radiate from the central point. (2.) A valve of eight rays (fig. 6): two simple lines and two triplets; four lines therefore radiate from the central point. (3.) Another valve with eight rays: one simple line, two forked and one triplet; four lines, as before, radiating from the centre, but by a different combination. (4.) A valve with nine rays (fig. 7): two simple lines, two forked and one triplet; in this case the divisions occur at a considerable distance from the umbilicus, and five lines emanate from the central point. (5.) A valve with ten rays: no simple line at all, but two forked and two triplets; only four actually radiating from the centre. (6.) A valve with eleven rays (fig. 8): one simple line, two triplets, and one quadruplet; still only four proceeding directly from the umbilical point. It will be obvious from the above statement, that there is a decided tendency in the umbilical lines of this species to arrange themselves in triplets. I regret that I have not space to admit of the entire series being engraved, but the examples I have selected will afford a good idea of the whole. It is worthy of observation that the valve I have represented at figure 6 seems, on a momentary glance, to possess what I have called median lines, which enclose Dr. Wallich's "basal ray" ("from the true rays being always arranged around or upon it"); but this is a deception. Median lines, according to my view, cannot exist apart from a median ray, and consequently are not to be found in this section of the genus. In the present instance it will be perceived, by a comparison with figures 7 and 8, that the appearance is caused by two triplets of umbilical lines happening to adjoin each other. The same effect is twice repeated in figure 8, only not quite so conspicuously. Dr. Wallich proposes to substitute the term "basal" ray for median or "obsolete" ray;* but as there is no instance on record of more than one median ray occurring in the same valve, he must use the term in a more enlarged sense in his highly interesting paper, when he ascribes three basal rays to the species he has done me the honour to associate with my name. In one of Professor Walker-Arnott's slides is an abnormal valve of *A. variabilis* with the hyaline area very eccentrical, and the whole having exactly the appearance as if it had been intended for a

* 'Trans. Mic. Soc.,' vol. viii, p. 45.

Spatangidum. It has six rays, the lower one much the longest; the upper one short, and the lateral ones slightly curved downwards. This accidental deviation from the ordinary arrangement of the valve in this species is immaterial, except as an additional illustration of the tendency in individuals belonging to the different sections of the group to partially assume the general appearance of each other.

4. *Asterolampra Grevillii.*—Areolated segments square at the base; rays numerous; umbilical lines divided and arranged in parcels or groups of from two to five lines each. Diameter about ·0034″. (Pl. IV, fig. 21, an abnormal valve.)

Asteromphalus Grevillii, Wall. Trans. Mic. Soc., vol. viii, p. 47, Pl. 2, fig. 15.

Hab.—Rappahannock Deposit, United States, Mr. E. W. Dallas. Indian Ocean, Dr. Wallich. Monterey stone, Professor Walker-Arnott.

The uniform character of the rays brings this species into the present section. The examples originally discovered by Mr. Dallas, and which I had described in MS. as unquestionably distinct, I have little or no hesitation in now referring to this place. Although no character can be strictly drawn from the number of rays, yet it would seem that in this diatom they are so numerous as to give it a peculiar appearance. The umbilical lines, as they radiate from the central point, are very few; but they almost immediately divide in such a way, that a group of lines seems to be supported, as it were, by a single short stalk. The frustule figured by Dr. Wallich has thirteen rays; the umbilical lines are combined into three groups; the three little stalks which support them alone radiating from the central point. One of the American specimens, of which I had prepared a drawing, contains fifteen rays; and the umbilical lines are combined into four groups, supported by as many little stalks. Another of the American specimens contains seventeen rays. The one with fifteen rays has four, which Dr. Wallich would call "basal;" that is, they unite at the umbilicus exactly in the same manner as do his three "basal rays" in his figure of the present species. Consequently, if I am right in considering the American and Indian individuals as identical, the species might be said to possess an indefinite number of such rays. But, as I have already remarked, this arrangement of the rays admits of a different and more satisfactory explanation. At figure 21 (Pl. IV), I have introduced a valve, from the

Indian soundings, having a very irregular and curious arrangement of the umbilical lines.

5. *Asterolampra Brébissoniana,* n. sp. Grev.—Areolated segments square at the base; umbilical lines with an angular bend in the middle. Diameter ·0030′. (Pl. III, fig. 9.)

Hab.—Monterey stone, Professor Walker-Arnott.

This may be regarded as one of Professor Walker-Arnott's most interesting discoveries, as it shows that the very remarkable angular bend in the umbilical lines, already known to exist in some species of *Asteromphalus* and *Spatangidium,* is not excluded from the present section; and therefore strengthens, in however small a degree, the argument in favour of the union of the whole group into one genus. I have much pleasure in dedicating so well-marked a species to M. Alphonse de Brébisson, whose name is so eminently associated with these wonderful structures.

SECTION II.—Rays unequal (one much narrower than the rest). Umbilical lines radiating from the central point; two of them approximated.—ASTEROMPHALUS.

6. *Asterolampra Hookerii.*—Areolated segments curved at the base; umbilical lines straight, the two approximated ones (median lines) parallel.

Asteromphalus Hookerii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 3; Kütz., Sp. Alg., p. 129; Pritch., Animalc., p. 321; Mic. Dict., p. 71, pl. xix., fig. 2; Ehr., Mikrogeol., pl. 35, A. xxi., fig. 2 (6 rays).

Asteromphalus Buchii, Ehr., Berl. Monatsb., 1844, p. 200, fig. 4; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71 (7 rays).

Asteromphalus Humboldtii, Ehr., Berl. Monatsb., 1844, p. 200, fig. 6; Kütz., l. c., p. 130; Pritch., l. c., p. 321, pl. xiv., fig. 34; Mic. Dict., p. 71; Ehr., Mikrogeol., pl. xxxv., A. xxi., fig. 3 (8 rays).

Asteromphalus Cuvierii, Ehr., Berl. Monatsb., 1844, p. 200, fig. 7; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71; Ehr. Mikrogeol., pl. 35, A. xxi., fig. 1 (9 rays).

Hab.—The Antartic Ocean, Dr. J. D. Hooker.

As the celebrated Ehrenberg regarded a simple difference in the number of rays as amounting to specific distinction, he has added a multitude of names to our list of Diatomaceæ which cannot now be permitted to retain their position. Such is pre-eminently the case in the genera *Actinocyclus* and *Actinoptychus,* which will probably be found ultimately to contain comparatively few true species. In *Asteromphalus* the same system was carried out. The four species now brought together are only distinguished by each individual having

one more ray than its predecessor. In every other respect they are precisely similar.

7. *Asterolampra Dallasiana*, n. sp., Grev.—Areolated segments square at the base; umbilical lines straight; median lines campanulate. Diameter ·0038″. (Pl. IV, fig. 10.)

Hab.—In "Bermuda Tripoli," Mr. E. W. Dallas.

The diatomist cannot fail to observe how similar this form is to some of the species described in the first section, with the exception only of the median ray and median lines. In general habit it is widely different from all the *Asteromphali* of Ehrenberg, but agrees more with the following species, also detected by my lynx-eyed friend, Mr. Dallas, in the same material. The precise locality of this famous "Tripoli" was for some time a mystery; but the readers of the 'Microscopical Journal' will be aware that Professor Walker-Arnott believes that he has traced it to a place called Bermuda, about twenty miles below Richmond in Virginia.* Considering that the genera *Heliopelta*, *Craspedodiscus*, &c., have never been found elsewhere, it may be said to be the most precious deposit known; and the discovery in it of two new species of the present section of *Asterolampra* will add not a little to its interest. It is remarkable, however, that if it really forms a part of the great Richmond deposit, nothing like it should have been found since the original supply passed into circulation.

8. *Asterolampra Wallichiana*, n. sp., Grev.—Areolated segments square at the base; umbilical lines straight, the two median one scuneate. Diameter ·0021″. (Pl. IV, fig. 11.)

Hab.—In "Bermuda Tripoli," Mr. E. W. Dallas.

Only one specimen of this species has been seen, and it is conspicuous for the polygonal aspect of the hyaline area, which resembles the disc of an *Ophiura*. There are only six rays, and the basal portion of each is so wide next the areolated segments, that it may be compared to a short-bladed trowel, while the linear part represents the handle. These relative proportions, however, may not be constant.

9. *Asterolampra Beaumontii*.—Areolated segments curved at the base; umbilical lines with an angular bend; median lines straight, parallel.

Asteromphalus Beaumontii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 5; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71, 2d edit, Pl. 43, fig. 15.

Hab.—Antarctic Ocean, Dr. J. D. Hooker.

* 'Mic. Journ.,' vol. vii, p. 254.

A very singular species, having the ordinary umbilical lines furnished with an angular bend in the middle, while the median lines are straight. It thus forms a transition from the previous species of the section to the following one.

10. *Asterolampra Darwinii.*—Areolated segments somewhat square at the base; umbilical lines with an angular bend; median lines cuneate, with an angle midway, furnished with a minute spine-like projection. Diameter ·0019″ to ·0035″. (Pl. IV, figs. 12, 13.)

Asteromphalus Darwinii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 1; Kütz., l. c., p. 129; Pritch., l. c., p. 320; Mic. Dict., p. 71 (5 rays).

Asteromphalus Rossii, Ehr., Berl. Monatsb., 1844, p. 200, pl. (June), fig. 2; Kütz., l. c., p. 130; Pritch., l. c., p. 321; Mic. Dict., p. 71; Ehr., Microgeol., pl. 35, A. xxi, fig. 4 (6 rays).

Hab.—Antarctic Ocean, Dr. J. D. Hooker. Monterey stone, Professor Walker-Arnott.

The determination of this species has been accompanied with a good deal of perplexity. The figures given by Ehrenberg represent the base of all the areolated segments as curved—not in the remotest degree as tending to square; whereas in the specimens obtained by Professor Walker-Arnott from the Monterey stone (all of them four-rayed), the hyaline area is decidedly quadrangular. Nay, more than that, the outline of the hyaline area between the median and adjoining rays is slightly but unequivocally convex instead of concave. It is difficult to conceive how so great an amount of error should have crept into Ehrenberg's figures, if the Monterey specimens be really the same. I confess that I am not quite satisfied on this point, although the umbilical and median lines agree. In deference, however, to Professor Walker-Arnott's opinion, I refer his Monterey valves in the mean time to this place, and offer representations of two examples, in order that the discrepancy between them and Ehrenberg's figures may be better understood. It will be noticed that there is some difference in the median lines in the two valves; but the absence of the angles in figure 13 may be regarded as accidental.

SECTION III.—Rays unequal. Umbilical lines radiating from the top and sides of the median lines; which latter pass beyond and enclose the central point.—SPATANGIDIUM.

* Umbilical lines without an angular bend.

11. *Asterolampra flabellata.*—Areolated segments curved

at the base; umbilical lines all straight, radiating from the apex and sides of the median lines. Diameter ·0017″ to ·0024″.

Spatangidium flabellatum, De Bréb., Bull. Soc. Linn. de Normand., vol. iii, Pl. 3, fig. 3.
Asteromphalus flabellatus, Grev., Mic. Journ., vol. vii, p. 160, Pl. 7, figs. 4, 5.
Spatangidium peltatum, De Bréb., l. c., Pl. 3, fig. 4.

Hab.—Peruvian Guano, De Brébisson. Californian Guano.

After a reconsideration of the claims for distinction put forth on behalf of the two diatoms above quoted, I cannot find any really trustworthy characters to separate them. The slightly arcuate rays in *S. flabellatum* will not alone suffice, as this appearance may be seen occasionally in species whose rays are normally straight; and the "subpinnate" disposition of the rays in *S. peltatum* is rather a deception, arising simply from the number being uneven, and the odd ray being placed on the apex, in the direction of the median lines. Beyond these two characters—the one as uncertain as the other—there is nothing to rest upon. The number of rays in the specimens I have seen is ten or eleven; but a larger series of examples would probably show a wider range. The areolation is very minute.

12. *Asterolampra Hiltoniana*, n. sp. Grev.—Areolated segments acutely curved at the base; umbilical lines radiating from the apex and sides of the median lines, the two lower pair suddenly deflexed. Diameter ·0038″ to ·0052″. (Pl. IV, fig. 15.)

Hab.—Algoa Bay Guano, R.K.G. Indian Ocean soundings, made by Captain Pullen.

On a former occasion, this species was referred to by me as probably distinct;* but at that time I had only seen two examples with ten rays each. In the Indian soundings I have met with numerous individuals (including fractured ones, which are often equally instructive), and my previous impression is fully confirmed. The latter specimens are much finer, the rays varying from fifteen to nineteen. Three of the umbilical lines on each side are generally deflexed, but the lowest two on each side are more or less suddenly bent downwards in the middle, either by a sharp curve or angle. In the African specimens the lines are all simple. So are they all in an Indian valve of eighteen rays. In the Indian one, however, which I have figured, with nineteen rays, three of the lines are forked. It is a very transparent species, and

* 'Mic. Journ.,' vol. vii, p. 160.

easily overlooked. The rays are slender, and the areolation very minute.

* * Umbilical lines with an angular bend.

13. *Asterolampra elegans*, Grev.—Areolated segments sharply curved at the base, more than half the radius; umbilical lines radiating from the apex and sides of the median lines, normally simple, but sometimes once or even twice forked. Diameter ·0030″ to ·0060″. (Fig. 16.)

Asteromphalus elegans, Grev.,'Mic. Journ., vol. vii, p. 7, Pl. 7, fig. 6, Wall. Trans. Mic. Soc., vol. viii, p. 46, Pl. 2, fig. 10?

Hab.—Californian Guano. Soundings from the Indian Ocean, in 2200 fathoms, made by Captain Pullen.

My figure formerly published represents a small normal example; but the specimens which occur in the Indian soundings present so extreme a deviation from the typical state, that an additional illustration becomes absolutely necessary. In most of these Indian valves there is a disposition in the umbilical lines to divide, or even subdivide; and this is done so irregularly that simple lines may be mixed with the forked ones. In three specimens now before me, the first, with seventeen rays, has three of the lines forked and one twice-forked. The second, with twenty rays, has four forked and one twice-forked. The third, a magnificent and perfect specimen, with twenty-five rays (fig. 16), has seven lines forked and one twice-forked; so that only five of the lines remain in their normal condition. A large specimen in Mr. Roper's cabinet, of which he has sent me a drawing, exhibits a still more whimsical aberration. It has twenty-nine rays, but only ten umbilical lines radiate directly from the median lines; of these, one is divided into six, another into seven branches. Four lines only are simple. In the sketch of another valve containing twenty-five rays, sent by Mr. Norman, six lines are simple. In these anomalous valves the angular bend becomes less conspicuous, because the ramification generally takes place at one or both angles of the bend; a fact which rather tends to strengthen my remark under *A. heptactis*, that where the angular bend exists, a ramulus however fine, or at least a disposition to originate a ramulus, may be also presumed to exist. The areolation of this species is extremely minute, and the rays are gracefully slender. I have some scruples about referring the valve, which Dr. Wallich has figured, to this place, without an opportunity of tracing its connection. The peculiar-looking median lines, robust rays, and apparently rather large areolation, seem to indicate a difference.

14. *Asterolampra imbricata*.—Areolated segments, sharply curved at the base, less than half the radius; rays numerous, robust; angular bends of the umbilical lines forming unitedly an oblong elliptical figure. Diameter ·0024″ to ·0034″. (Fig. 17.)

Asteromphalus imbricatus, Wall., Trans. Mic. Soc., vol. viii, p. 46, fig. 9.

Hab.—*Salpæ*, Bay of Bengal, Dr. Wallich. Soundings from the Indian Ocean, in 2200 fathoms, made by Captain Pullen. Natal, Mr. Roper.

One of the most distinct and beautiful species I am acquainted with. The appearance of the valve is singularly rich, the usual parts being so arranged as to present successive series of radiations. The umbilical lines are given off from the top and sides of the median lines in such an equal, symmetrical manner that the angular bends are in close and parallel approximation. The oblong-elliptical line thus formed, taken at its widest part, is about a third of the radius, and constitutes what may be called the first zone in the radiation. The continuation of the umbilical lines to the base of the segments, taken along with the enclosed basal portions of the rays, forms a second zone; and the narrower portion of the rays, with the areolated segments, a third zone. As all the specimens which I have examined differ somewhat from Dr. Wallich's figure, I have thought it desirable to give a supplementary one, of a valve with twenty-one rays. I have another drawing of an equally perfect valve, with seventeen rays, in all respects similar. In my valves the median lines taper down beautifully to the median ray, and exhibit an abortive angular bend at the proper place. The most material difference, however, between Dr. Wallich's figure and my specimens consists in the wide space represented by him between the two lowest rays and the median ray; whereas in my extensive series of valves there is no greater space than there is between any of the other rays; indeed, in most frustules, the space is rather less. The outline of the valve is slightly, but perceptibly, ovate; the areolation considerably larger than in *A. elegans*, its nearest ally. It is the most robust species which has occurred in the Indian soundings, and hence, perfect individuals are not quite so rare as in other cases. Among Mr. Roper's drawings is one of a valve from Natal, with only ten rays, and in diameter only ·0015″. In all material characters, however, it agrees well with the present species.

15. *Asterolampra Brookei*.—Valve nearly quite circular;

areolated segments nearly square at the base; angular bend of the umbilical lines situated towards the outer extremity; median lines scarcely passing beyond the central point, arched at the top, then contracted, afterwards more or less divergent. Diameter ·0028′′ to ·0036″. (Fig. 18.)

Asteromphalus Brookei, Bail., Sill. Journ., 2d ser., vol. xxii, p. 2, Pl. 1, fig. 1.

Hab.—Sea of Kamtschatka, in soundings made by Lieut. Brooke, in 1700 fathoms, Professor Bailey. Atlantic soundings, Mr. Roper.

Were it not that I possess specimens of this species from Professor Bailey himself, I could scarcely have recognised it from the brief notice he has given of it in 'Silliman's Journal,' and still less from the figure which accompanies it. The fact is, the characters which he attributes to it are now shared in common with other species, and we have to look for other distinctive marks. In some points, the species is allied to *A. Roperiana*, being apparently quite circular, and having the base of the segments square, or nearly so. An additional resemblance is also found in the median lines, which scarcely cover the central point, being arched at the top, then contracted, and lastly expanded, though not to the same extent as in the species just mentioned. Professor Bailey's figure represents the base of the segments as decidedly curved as in *A. Marylandica*, but they are more nearly square, and in some valves quite so. The umbilical lines radiate from the upper half of the median lines, and are sometimes branched. There is an angular bend, nearer to the outer extremity than in any other species, and at each angle the minute spine-like process indicates probably the base of a ramulus. This may also be seen at the base of the median lines. The areolation is conspicuous. The number of rays, according to Bailey, varies from seven to thirteen, or more; in my specimens they are from ten to twelve. The frustule, when perfect, is very convex.

16. *Asterolampra Roperiana*, n. sp., Grev.—Valve circular; hyaline area centrical; areolated segments square at the base, almost equal; rays seven; median lines passing round the central point in a semicircle, then contracted below, and lastly widely expanded. Diameter ·0028″ to ·0066″. (Fig. 14.)

Hab.—Indian Ocean, in soundings made by Captain Pullen, in 2200 fathoms.

It is unnecessary to repeat the remarks which I have already made on this most interesting diatom, as constituting

a link between the last and the present section. In fact, had the two median lines united *at* the central point instead of being carried just *round* it, it would have been included in the last section. In other words, it would have been an "*Asteromphalus*," instead of a "*Spatangidium*." The six perfect rays are broad, and equal to the margin, like those of De Brébisson's *Spatangidium heptactis*. The umbilical lines have an angular bend, which is so obscurely developed as to be liable to be overlooked; but the indication of the bend in the median lines, towards the margin of the hyaline area, is more conspicuous. When carefully looked for, however, they will be perceived without difficulty. I have even succeeded in tracing in two specimens very slender ramuli, passing from the angles of the bend to the angles at the base of the segments, exactly as in *Spatangidium heptactis;* but to do this requires the most careful adjustment possible, and such a management of illumination as to throw the umbilical lines, and ramuli, and edges of the ray cavities into a *light* definition. The umbilical lines, including the median ones, are robust, and the areolation rather large. The valves seem very constant to the characters given, as I have tested by an examination of above a dozen specimens. In one only did the median lines vary, in becoming widely sub-parallel, instead of diverging. Perfect examples are very rare. The individual figured is the most perfect; but by no means the largest in my cabinet.

17. *Asterolampra Shadboltiana*, n. sp., Grev.—Areolated segments square at the base; umbilical lines radiating from the arch of the pyriform median lines, with the angular bend about the middle; rays seven, terminating considerably within the margin. Diameter ·0031". (Fig. 19.)

Hab.—Indian Ocean, in soundings obtained by Captain Pullen, in 2200 fathoms.

Mr. Roper very kindly sent both his accurate drawing and the slide containing the valve of this interesting species for my inspection; and I have since been so fortunate as to discover a second example for myself, so minutely similar that the engraved illustration might have been taken from either specimen. It seems to be a really well-marked diatom. Its nearest ally is perhaps *A. Brookei*, from which it is separated by the very different median lines, and by the angular bend being more in the middle of the umbilical lines. If the termination of the rays so much within the margin of the valve, and singularly short median ray, prove permanent characters, they will serve still farther to distinguish the present species. I suspect, also, that, as in *A. Roperiana*,

A. heptactis, and *A. Arachne*, the number of rays may be more constant than is generally the case in the group. The areolation is rather large.

18. *Asterolampra heptactis*.—Segments square at the base; rays seven, six of them broad, linear, subarcuate, the median one in a broad shallow groove; umbilical lines with a ramulus proceeding from each angle of the bend; areolation large. Diameter ·0018″ to ·0070″.

Spatangidium heptactis, De Bréb., Bull. Soc., Linn. de Normand., vol. iii, pl. 3, fig. 2.
Spatangidium Ralfsianum, Norm., Grev. Mic. Journ., vol. vii, p. 161, pl. 7., figs. 7, 8.

Hab.—Peruvian Guano, De Brébisson. Californian Guano, R. K. G. Atlantic soundings, Mr. Roper.

The extraordinary discrepancy between the figure, with part of the character in De Brébisson's paper above quoted, and the numerous specimens of the diatom itself, which I had examined, led me formerly to regard Mr. Norman's *Spatangidium Ralfsianum* as a distinct species. The broadly ovate outline of the valve delineated by De Brébisson, and the statement in his specific character, that the median ray was the longest, were opposed to my own experience; for I had ever found the valve broadest in the transverse direction, and the two lower lateral rays the longest. I still consider that my figure 8, above quoted, is typical of the species, as it agrees with the vast majority of specimens. While, however, I was supported in my view by some diatomists, others were against me, and I am at length satisfied that we had the same organism in view. Among some careful drawings of his own making, which Mr. Roper kindly permitted me to consult, are two of this species, and in one of them there is a slight approach towards a broadly ovate outline, and the median ray is the longest; but this is decidedly an exceptional case, unless, indeed, the Peruvian frustules differ in contour from those of California. There is a curious feature in this species which I did not formerly notice: the very slender ramuli which proceed from each angle of the bend in the umbilical lines terminate at the angles of the areolated segments, in a line with the margin of the broad rays; the consequence of which is, the two small spaces enclosed by these ramuli, at the base of each of the segments although they form a part of the hyaline area, are excluded from the basal portion of the ray. It may be observed also, that as in this fine species, as well as in *A. Roperiana*, the angular bend is distinctly connected with a system of ramification, it may

be inferred with some degree of confidence, that it is an important character when met with in other species. Little spine-like processes are seen to project from the angles in several allied forms, and may be the basis of similar ramuli. In the diatom under consideration, the base of each ramulus is conspicuous, but it appears at first sight to stop abruptly, and it requires very careful adjustment to trace the fine continuation to the angle of the segments. In other species, while the spine-like base is sufficiently obvious, the very delicate continuation may escape observation altogether. The colour of the valve is very pale yellow; the areolation larger than in any other member of the group.

19. *Asterolampra Arachne.*—Valve broadly ovate; hyaline area very small and eccentrical; areolated segments curved at the base, the upper one very widely, the lateral ones sharply; umbilical lines two, lateral; median lines dilated upwards; rays five, the two superior ones curved upwards, widely apart. Diameter about ·0021″.

Spatanidium Arachne, De Bréb., Bull. Soc. Linn. de Normand., vol. iii, pl. 3, fig. 1.

Asteromphalus malleus, Wall., Trans. Mic. Soc., vol. viii, p. 47, pl. 2, fig. 11.

Hab.—Peruvian Guano, De Brébisson. In *Salpæ*, Indian Ocean, Dr. Wallich. Indian Ocean, in soundings at 2200 fathoms, made by Captain Pullen.

It would be fortunate for the student if diatoms were in general as faithful to their characters as this remarkable species. It is one of the few belonging to the present group, of which it may be said that the number of rays is really constant. Their disposition is also very peculiar. The hyaline area is so small as scarcely to be perceived at first sight, being composed merely of the very short suddenly dilated bases of the four perfect rays and the space enclosed within the short median lines. The rays are attached to the sides of the median lines, nearly the whole of which they occupy. The upper pair turn their backs, as it were, on the lower pair, curving outwards and upwards, and bear much the same relation to the median lines as the horns of an ox do to the frontal bone. The lower pair of rays are straight, and point laterally downwards, forming a group of three with the median ray. The median lines also exhibit a character peculiar, I believe, to this species, in not being united at the top; they do not even incline towards each other, but stop abruptly, leaving the intervening space in juxtaposition with the base of the upper areolated segment. Another anomaly occurs in this part of the valve, in the segment just mentioned being unsupported by an umbilical line. The areolation is large; and

the colour of the valve, even when mounted in balsam, brownish yellow. Two specimens only have occurred to me, in the Indian Ocean soundings.

20. *Asterolampra Sarcophagus.*—"Valve oblong, with a slight constriction near each extremity; basal ray plane, and continuous with one of the true rays; sutures plane; cellules very large. Length ·0018"; breadth ·0009"."

Asteromphalus Sarcophagus, Wall., Trans. Mic. Soc., vol. viii, p. 47, pl. 2, fig. 12.

Hab.—Indian Ocean, from *Salpæ*, Dr. Wallich.

As I have not had an opportunity of examining this very curious diatom, I give the specific character in Dr. Wallich's own words. The form of the valve is so extreme a deviation from the otherwise more or less orbicular shape of the entire series, that an impression almost forces itself upon the mind that it is simply a malformation. Dr. Wallich does not mention how many individuals have come under his notice, but he has probably seen a sufficient number to satisfy him that its eccentricity of outline is permanent. It is most nearly related to *A. Arachne;* for if we remove the terminal ray (which in many species may be either present or absent), the five remaining rays would occupy the relative position which they hold in that species, as well as the same direction; one pair of perfect rays pointing upwards, the other pair downwards. In both species also the areolation is large.

Among several frustules of which I have only seen single specimens, and whose position is doubtful, is a minute and beautiful valve, of which I give a figure (fig. 20). It is allied to *A. Hiltoniana* and *A. flabellata,* but cannot be satisfactorily referred to either. The lowest pair of umbilical lines are curved downwards, as in the former species. The median lines are parallel, and continued to the edge of the hyaline area, or, in other words, to the base of the median segments, in a decidedly square manner. The valve, at a first glance, is most conspicuous for the large size of the hyaline area and the consequently rapidly attenuated rays; but this may prove to be a worthless distinction. It is only ·0018" in diameter. I shall not attempt a formal character, but it may bear, for the sake of convenience, the provisional name of *A. stellata.* It occurs in the Indian Ocean soundings.

Asteromphalus centraster, of Dr. C. Johnston, from Elide Guano ('Mic. Journ.,' vol. viii, p. 12, Pl. I, fig. 10). I cannot speak of with any certainty. The rays, in being continued like distinct bars, or the ribs of an umbrella, from the central point to the margin, are unlike those of every known species of the group. There is evidently no true median ray.

ON THE STRUCTURE OF CARDUELLA CYATHIFORMIS. *A contribution to our knowledge of the* LUCERNARIADÆ. By Prof. ALLMAN, F.R.S., &c. &c.

IN the month of August last, during a short sojourn among the Orkney Isles, my attention was directed by Mr. Gilchrist of Stromness, to a little Lucernarian zoophyte, which he had discovered attached to stones near low-water-mark, in the neighbourhood of that town.

The little animal proves to be identical with the *Lucernaria cyathiformis* of Sars; but its characters are such as to convince me that it must be separated from the true *Lucernariæ*, and assumed as the type of a distinct genus in the family of the *Lucernariadæ*. That I am justified in this view, will, I think, appear from the following description:—

Fam., LUCERNARIADÆ.

Gen., CARDUELLA, mihi.

(*Name.*—A diminutive noun from *carduus*, a thistle, in allusion to its form.)

Gen. Char.—Body stalked; tentacles capitate, not tufted, springing from within the margin of a circular disc in a single series.

C. cyathiformis, Sars.—Body urceolate; peduncle dilated at its base into a disc for attachment; tentacular circle interrupted at about eight nearly regular intervals, by the non-development of certain tentacles.

Synonym.—*Lucernaria cyathiformis*, Sars, in Fauna lit. Norveg.; Johnston, Brit. Zooph., 2d Ed., p. 475, fig. 86.

Hab.—On stones near low-water-mark.

Localities.—Coast of Norway, *Sars;* Island of Arran, Scotland, *Rev. D. Landsborough;* Stromness, Orkney, *Mr. Gilchrist* and *G. I. A.*

Carduella cyathiformis is about half an inch in height. The body is hemispherical posteriorly, where it is seated on the summit of the peduncle; it then contracts behind the tentacular circle, and then again expands into a wide circular disc, whose margin is not produced into rays, as in the true *Lucernariæ*, and which has the mouth in its centre. The tentacles, slightly tapering from the base, and each ending in a spherical capitulum, do not, as in *Lucernaria*, spring from the edge of the cup, but from a circle situated at some distance within it, and in the fully expanded state of the animal extend about as much again beyond it.

The tentacular circle is interrupted at four nearly regular

intervals; but all the tentacles are situated in a single circle, and never form tufted groups as in *Lucernaria*.

Each of the four interruptions in the continuity of the circle of tentacles is caused by a single tentacle having that at each side of it arrested in its development, so as to present under the lens the appearance of little conical papillæ (Pl. V, fig. 3, *m*), while the developed tentacle, situated between the two arrested ones, is invariably bent over the edge of the cup in the expanded state of the animal (figs. 1, 3,) and thus renders the interruptions in the circle still more obvious. Not unfrequently, other interruptions are observed in the tentacular circle, caused by a similar abortion of one or more tentacles; but these are less regular in position, and less constant in occurrence, than those just described.

In the centre of the oral disc is a prominent four-lobed mouth, and the extremities of the four generative bands may be seen projecting from below each angle of the mouth, and distinctly visible through the disc, by the greater depth of their colour.

The peduncle is distinctly annulated both in the extended and contracted state, and terminates below in a little disc-like dilatation, by which the animal fastens itself to the rock; but I cannot find that it has the power of detaching itself when it has once become fixed.

The colour of *C. cyathiformis* is a brownish-red, with the stomach and generative bands conspicuous, by their deeper colour, through the semi-transparent walls of the body; while, just behind the bases of the tentacles, the body is marked by a deep-brown circle; and four paler lines, separated from one another by equal intervals, extend backwards from this circle to the summit of the peduncle.

It was a very frequent thing to meet with two individuals growing from a single basal disc; but this I believe to be a case of simple fusion from contiguity, and not an example of gemmation or other form of zooidal multiplication.

Carduella cyathiformis is one of the most elegant members of our littoral fauna, and rarely will the wanderer along the shore at low tides have his search more amply rewarded than by the capture of this charming little zoophyte.

Anatomy.—A transverse section (fig. 4) made about the middle of the body, or a longitudinal section (fig. 3) passing through the axis, shows an outer bell or umbrella (*a*), traversed in its axis by a quadrilateral, elongated stomach (*b*). In the walls of this stomach, along each of its four angles, runs a double lobulated band (*c*), which projects into the cavity of the stomach, and is the seat of the ova or spermatozoa.

From the outer side of the walls of the stomach there extend to the umbrella eight membranous vertical lamellæ (figs. 3, 4, *d*). These are so arranged, that from each of the angles along which one of the four generative bands runs two lamellæ are given off, and thence diverging at a wide angle, are attached by their outer edges to the inner surface of the umbrella, along a longitudinal ridge (*e*), which also gives attachment to one of the lamellæ of the neighbouring pair. There are thus four of these ridges, each giving attachment to two lamellæ, and situated alternately with the four angles of the stomach to which the opposite edges of the lamellæ are attached.

The result of this arrangement is the formation of eight spaces, four of which (*f*) are situated externally, while the other four (*g*) alternate with these and lie internally.

The four outer spaces are closed above, and their roof thus forms the oral disc (*h*) of the animal; while the four inner spaces are open, and allow a needle to be passed down along the side of the stomach the whole way as far as the peduncle.

Each of the four ridges, along which the vertical laminæ are attached to the inner edge of the umbrella, seems to be traversed through its entire length by a canal. They are visible in the living animal through the walls of the umbrella, where they appear as four pale-coloured lines, extending symmetrically from the summit of the peduncle as far as the tentacular circle.

Running along the bases of the tentacles, so as to form a continuous circle at some distance within the margin of the disc, is a deep reddish-brown line (*i*), which I have no hesitation in viewing as a circular canal, into which the tubular tentacles all open.

Upon the inner surface of the stomach are eight longitudinal rows of tubular appendages (*k*), two rows being situated in each of the four intervals between the generative bands. They are finely ciliated on their surface, and have their walls loaded with large thread-cells.

I have not satisfactorily made out the structure of the peduncle; but it seems to present the principal parts demonstrable in the body, namely, the umbrella, stomach, and generative bands, compressed into a smaller space and less distinguishable from one another.

Round the margin of the umbrella runs a band of circular muscular fibres (*l*), which performs the office of a sphincter in closing the mouth of the umbrella during the contracted state of the animal; while other fibres radiate in the oral disc, where they may be seen converging from the circular

canal at the base of the tentacles towards the central stomach.

In the ova (fig. 5), the germinal vesicle and germinal spot are distinct; and the spermatozoa (fig. 6) present a characteristic hydrozoal form, consisting of conical corpuscles, with the caudal filament attached to the broad end of the cone.

Homologies.—As to the true import of the structure now described, it will be easily seen that we have in it a genuine hydrozoal type, notwithstanding a certain superficial resemblance to the structure of the *Actinozoa*. The point which at first sight seems to remove it most widely from the *Hydrozoa*, and approximate it to the *Actinozoa*, will be found in the presence of the vertical lamellæ which connect the stomach with the outer wall of the animal. A little attention, however, will show that these must on no account be confounded with the radiating lamellæ of an *Actinia*, from which they differ entirely in their arrangement and relations.

The axile stomach of *Carduella* is exactly the *manubrium* of a Medusa, while the external body-walls correspond to the *umbrella;* and if I am correct in my interpretation of the appearances which lead me to believe in the existence of longitudinal and circular canals, we have in them the exact representatives of the radiating and circular canals of the gastro-vascular system of a Medusa.

As to the homology of the oral disc, I cannot help seeing in this muscular membrane the representative of the muscular *velum* of a gymnophthalmic Medusa, which, instead of being, as in the Medusa, free towards the axis of the animal, is here united to the stomach, while it is at the same time extended and so folded into plaits, as to form by the union of these plaits alternately to the stomach within, and to the umbrella without, the four pairs of vertical lamellæ; and although what we know of the development of the *velum* in the Medusa can scarcely be said to give any direct support to this view, it certainly is not inconsistent with it.

It will now be seen that it is with the *gymnophthalmic*, rather than with the *steganophthalmic* Medusa, that the affinities of *Carduella* are to be sought. We have, indeed, only to conceive of a gymnophthalmic Medusa, with its stomach (manubrium) united to the umbrella along four equidistant longitudinal lines through the medium of a peculiarly plaited velum, in order to convert it, so far as regards the most important points of its structure, into a *Carduella*.

On the Development *and* Structure *of the* Diatom-valve.

By G. C. Wallich, M.D., F.L.S.

In a paper recently published in 'The Annals and Magazine of Natural History,' I endeavoured to show the unfitness of the valves of the Diatomaceæ as standard tests for microscopic lenses, and based my objections to their employment on the variable character of the markings in different individuals of the same species, in the same species under varying conditions of development, and in the same specimen under different methods of examination. In dealing with this subject, I purposely selected *Pleurosigma angulatum* and *P. balticum*, the forms most frequently referred to, without assuming, for a moment, that the markings of these, or any other diatoms, are of sufficient importance, in a biological point of view, to entitle them to interest; and solely because it became imperative on me, whilst condemning tests hitherto relied on, to prove that some of those most constantly in use, and in the delineation and description of which the greatest pains has been taken by writers, exhibit characters irreconcilable with the structure usually assigned to them.

In the following observations, I shall principally endeavour to prove that growth does not take place in the diatom valve, after its primary development; and that the variation observable in the size and markings of different individuals of the same species is not only consistent with this view, but naturally follows from it.

The mere discussion as to whether the surface of a valve exhibits this or that kind of markings, so long as no higher purpose is in view than the production of certain appearances under the microscope, and the claim of superiority for the instrument whereby the most Protean aspects are engendered, must always remain barren of scientific results. For we are bound not only to see, but to comprehend the relation of one portion of minute structure to another, before we are in a position to draw serviceable inferences from it. It is well understood, by all who have had experience in microscopic manipulation, that great caution is necessary in pronouncing upon the precise structure of an object; and that, under imperfect adjustments, either as regards the object or the instrument, an indefinite amount of variation may be made apparent. This is especially the case under the employment of the higher powers. For, although the definition of the entire series of objectives, manufactured by our leading opticians, may be said to be equally perfect, a variety of

conditions are essential to secure accuracy of observation, and these can only be fulfilled under the exercise of the strictest vigilance and judgment.

But whilst the minute structure of the diatom-valve may be deemed by some persons unworthy of the labour that has been bestowed upon it, it is indisputable that the correct exposition of that structure involves a question, quite as important, perhaps, as any we have to encounter in the whole course of vegetable physiology; and however cynically some of our intellectual eagles may affect to treat the subject, they may rest assured that no little honour awaits the observer who shall place the laws by which it is governed in an intelligible light.

Why, let me ask, does one organism present peculiarities in the arrangement of its cell-wall which do not occur in another immediately allied to it? Why do we find organisms belonging to the same group, formed on the same general plan, surrounded by the same influences, and deriving nourishment from the same medium, vary so remarkably in the disposition of one of their elements, in which we should least expect to meet with variability? Thus, amongst the Diatomaceæ, why do we observe such differences between the arrangement of the siliceous particles in *Triceratium* and *Campylodiscus*, *Campylodiscus* and *Pleurosigma*, or *Pleurosigma* and *Pinnularia*, and so on with the remaining genera? As nothing in nature is, or indeed can be, fortuitous, some law must operate in bringing about these differences. Although as yet ignorant of the nature of that law, there is no reason whatever why we should remain so. Day after day brings forth fresh facts, in elucidation of the complicated scheme of creation; and no one can tell, therefore, how great a length of the chain of knowledge may be consolidated, by the addition of a link snatched from objects holding no higher place in the scale than the unpretending diatom.

Other more startling discoveries have been effected, and have earned for the discoverers greater *éclat;* but it is doubtful whether any have surpassed in physiological value Schwann and Schleiden's enunciation of the theory of cell-formation. On this basis the study of the entire organic world may be said to rest. It is the groundwork of our acquaintance with the structure of every living thing, from the lowest protophyte up to man. But there is a link, yet beyond that point, which requires to be filled up and riveted. I allude to the law that presides over the development of the cell-wall; and this, I conceive, can hardly be studied more advantageously than amongst the Diatomaceæ, the indestruct-

ible nature of which, coupled with their extreme transparency and the already understood chemical relations of their siliceous element, renders them so well fitted for the inquiry.

It is admitted on all sides that the rules by which species have heretofore been established demand material modification. Amongst the Diatomaceæ, a line, a dot, a minute spine, or a variation in size or outline, amounting, relatively speaking, to nothing more than we see occurring amongst individuals of the same species of every animal and plant in nature, has been accepted, by some observers as of sufficient moment to constitute a specific character. Almost every microscopist has fallen more or less into this error. But it is by no means an error confined to one class of observers; for entomologists, botanists, and conchologists are in exactly the same predicament. So that our knowledge of the minute Fauna of the globe, after all, is but in the same state as that of other branches of natural history, making due allowance for the multiplied difficulties by which microscopic investigation is specially beset.

Now, in the case of the Diatomaceæ, the leading generic characters are taken from the configuration of the siliceous valve. The sooner, therefore, that we gain such an insight into the law which regulates the deposit of the silex, as shall enable us to judge how far the differences of configuration may be dependent on chemical or molecular forces, and how far on the inherent property of the organisms themselves, the sooner shall we have it in our power to establish a natural classification, and to simplify, by rendering determinate, the methods of investigation.

We have before us the phenomenon of a mineral, eliminated or secreted by what we are pleased to denominate a simple cell, in a state of the utmost purity, and assuming definite forms, which may be said to hold an intermediate position between crystallization and simple molecular aggregation. We know the fact, but as yet we know absolutely nothing of the causes producing it. Surely then the investigation of such a problem is worthy of the best efforts of the microscopist; and from this point of view, even the "dot" may exercise a world of significance.

But whilst it is necessary that we should possess a clear idea of the structure of the siliceous wall of the diatom, it is by no means essential that we should have at our finger ends the precise nature of the surface in the more minute and subtle forms, or indeed in any save those that are typical and most easily revealed. If analogy means anything at all,

it surely authorises us to accept as most closely allied in structure those forms which, by universal consent, have been arranged side by side. We are sure to meet with stronger and more reliable analogies amongst the several species of the same genus, than amongst those of distinct genera. The statement of the one fact is but a statement of the other. And, for this reason, it is obvious that, in microscopic investigation, we are warranted in resorting to the most strongly marked and most readily observed species of a genus, when we attempt to draw general conclusions regarding its organization.

I allude just now more particularly to the genus *Pleurosigma*, of which a species, *P. angulatum*, has been handed down from writer to writer, both in Great Britain and abroad, as the one, *par excellence*, presenting us with typical structure. That it does exhibit structure identical in every essential particular with that observable in the rest of the species of that genus is undeniable. But, although by no means a difficult object for a quarter-inch lens of good construction, the markings on its valves are much more minute and delicate than is the case with other species; and accordingly the risk of misinterpretation, when it is viewed under higher powers, is necessarily augmented. I shall therefore select two other forms as typical of the rhomboidal and quadrangular structure, in which the characters can be made palpable both more easily and more distinctly.

Before entering, however, on a description of the structure in *Pleurosigma*, I would briefly point out the manner in which it appears to me the Diatomaceous frustule is developed; and to what extent the variations of conditions, to which it is subject during such development, seem likely to affect the siliceous deposit.

In the first place I would mention, that there is no evidence of growth proceeding continuously in the diatom-valve—if by growth be meant the increase and extension of the entire structure in every direction, as occurs in the higher orders of the vegetable kingdom. Some writers have endeavoured to account for the variable character of the striation in certain species, by asserting that, although the number of striæ in a minute fractional part of an inch is subject to considerable variation, the total number of striæ on the valves of all individuals of the same species or varieties is not liable to the like amount of deviation. In other words, they consider that the siliceous valve is capable of continuous growth; and that, whilst no fresh striæ are added to the valve, the distance between the several striæ may be augmented. Others again

modify this view by supposing that an addition may take place to the actual number of the striæ.

Now, whilst I fully admit the correctness of the first of these premises,—namely, that whilst the total number of striæ on a valve is nearly uniform in all the individuals of a given species orvariety, the number of striæ upon the fractional part of the valve admits of very great variation,—I dissent entirely from the opinion that the number of the striæ in a fractional part of a valve is capable of modification, either by the extension of the valve through growth, the total number of the striæ remaining the same, or by additional striæ being produced within the limits already attained.

The fact is, that the variation in the size of the valve and the number of its striæ proceeds, *pari passu*, during the progress of division, but not subsequently. Growth may take place to the extent of fresh siliceous matter being secreted along the margins of the valve, its depth being thereby somewhat augmented; but it is highly probable, for reasons which shall immediately be adduced, that the connecting zone, by which the young valve is protected during its secretion and consolidation, determines the limit of the dimensions to be attained by it; and although the young valve may still have to undergo a certain degree of consolidation, the whole of the characters, as we observe them under the microscope, are indelibly and unalterably impressed upon it, either before or almost immediately after its liberation. In like manner, the two rings of the connecting zone grow lengthwise by secretion of fresh siliceous matter at one of their margins only—as was shown by me in a former communication to the 'Microscopical Journal' (vol. vi, p. 224)—and they are thus enabled to slide out, one from the other, telescope fashion, and to accommodate themselves to the increase of their contents during division. The last feature is strikingly manifest in such genera as *Biddulphia, Amphitetras, Isthmia, Grammatophora,* and others.

I believe I am quite correct in stating that it very rarely, if ever, happens that an imperfectly developed—that is, an immature—valve is found associated with one of the parent valves from which it was derived, after the separation of the parent connecting zone; whereas we constantly meet with such a combination prior to that event. In the next place, whensoever we find, through the evidence of the still persistent connecting zone, that a young valve has but recently been perfected, its structure presents no peculiarity whereby it can be pronounced to differ from the parent valve with which it is associated. We frequently meet with frustules, furnishing incontestable evidence of recent division having

taken place, as just stated, equalling in dimensions the largest specimens of the species to which they belong. And, lastly, we never meet with such differences in size and markings as would, of necessity, result, did growth continue in the terminal parent valves of an elongated filamentous species; whilst the central or most recently produced valves exhibit only the size and markings attained by the parent valve at the period at which the first occurrence of division intervened.

A further and most remarkable confirmation of the view, that growth does not take place in the valve after its liberation from the parent connecting zone, is, I submit, derived from an abnormal form of *Triceratium favus*, a figure and description of which are given by Mr. Brightwell, in the 'Quarterly Journal of Microscopical Science,' vol. i, p. 246. In this specimen, an oblong portion, equal in extent to about one third of the entire valvular surface, is cleft out, as it were, from one of the angles. It is evident that, from whatsoever cause this configuration occurred, that cause must have taken effect whilst the valve was still in the plastic condition, to which reference has been made; for the cleft margin is fringed by a regular series of quadrangular cellules, such as we frequently observe along the inflected edge of the valve in the species under notice. As the specimen must have been subject to the action of acid or heat, before its intimate structure could have been examined and figured, it is equally evident that the valve had attained its mature and perfected condition. It should be borne in mind that the valve is of normal outline and configuration on the remaining surface. There is no projection from the sides or angles, indicating that the object to which the abnormal development was due had taken effect after the complete valve had been deposited; but, on the contrary, it is clear that such object must have presented an obstacle to the complete development of the valve whilst it was retained within its parent connecting zone. From the shape of the emarginate portion, it would appear to have been produced by growth taking place around some substance, such as a calcareous or siliceous spicule. From its not having been retained *in situ*, we may infer—either that, being siliceous, it had broken its way out at the deficient angle; or, being calcareous, that it had been dissolved during the operation of cleaning by acid. It is hardly possible to conceive that an object could pierce the already perfected and consolidated diatom-valve. But, supposing that possible, it is certain that fracture must have resulted, or that an extent of valvular surface must have been displaced of equal bulk to the emarginate space.

It may be asked, then, to what cause are we to attribute the

variation in dimensions that occurs so frequently? If not to growth, in the ordinary sense, to what other cause? It is attributable, in the first place, to increased or diminished supply of nutrition to which the species happens to be subject; acting by the production of differences between the parent and the young valve, wholly inappreciable to our vision, notwithstanding all our appearances, but yet quite capable of effecting the variation in question, through the intervention of a multitude of individuals. In strict truth, no two valves of the same frustule can be of the same size; for the new valves, being formed within the connecting zones of the parent frustule, must be smaller than these. In answer to this it may be urged that, in the usual course of growth, they reach the dimensions of the parent valve. But unless we are prepared to admit that the latter obligingly cease growing for a time, to permit of the requisite uniformity in size being attained, it will be seen that this objection is invalid. The difference in the two valves arising from the last-mentioned cause, however infinitessimal it may appear in the case of the individual, becomes, nevertheless, all-powerful when operating through vast successions of individuals; and is, therefore, of itself sufficient to account for the variations we witness.

The main source of difference, however, in the size of the valves of any given species is derived from the peculiar idiosyncrasy of the sporangial frustule. The large dimensions that frustule attains in many cases is well known. And, although the precise history of the produce of the sporangial cell still remains doubtful, there is, I believe, quite sufficient evidence forthcoming to show that the prevailing opinion, as to the great variation in dimensions of the new brood, is quite correct. If we bear in mind the vicissitudes of climate and locality to which the sporangial cell may, under certain circumstances, be subjected, we can readily understand, moreover, how increased or diminished sources of nutritive matter, dependent on those vicissitudes, may affect the produce of that cell towards either extreme.

In *Isthmia*, a genus offering remarkable facilities for the detection of differences between the size of the old and the new valves of the frustules, after careful and oft-repeated examination, I have been quite unable to detect any differences independent of the causes associated with the connecting zone to which reference has already been made. In this genus and in *Biddulphia*, the overlapping of the two rings of the connecting zones is more strikingly manifest, perhaps, than in any other forms, and the entire frustules are often of such magnitude as to enable us clearly to distinguish the contrast,

in internal area, of the two valves, arising from this source. In *Isthmia*, we also sometimes observe great variation as to length and breadth of frustules growing upon the same object. But it will be found that these marked differences do not occur in the same filament, but on separate ones; and that the primary frustule, or rather that valve of it by which epiphytic adhesion was first secured, frequently does not exceed in size the smallest of any of the other neighbouring terminal frustules.

After similarly extended observation of the compressed filamentous genera, I have never found any ground to alter my views respecting the determinate period during which the siliceous value may be said to increase; and, as an example in point, and one which, for several reasons, is amongst those best fitted to test its correctness, I would mention having carefully measured, by means of Ross's screw micrometer, frustules of the three species of *Rhabdonema*, at intervals, in filaments numbering as many as a hundred individuals, without the discovery of any difference in the length of the valves of sufficient magnitude to be referable to any other cause. When it is recollected that, in this genus, the frustules are annulate, and the entire structure would appear specially liable to variation in size, from the repetitive process alternating, as it were, with the extension of the frustule through the deposition of the annulate portions, it will be admitted that a more satisfactory test genus could not have been selected. I would add, for the guidance of those who may desire to repeat these measurements, that a source of fallacy exists which must be carefully guarded against; namely, the change of apparent size depending on the structure under examination not being placed perfectly flat upon the surface of the slide. A very little management will, however, suffice to ensure the proper position.

As regards the cell-contents, and the gelatinous envelope by which the whole of the Diatomaceæ are, in a greater or lesser degree, surrounded, growth goes on, in all probability, indefinitely. The present observations must be understood to apply, exclusively, to the siliceous valve of these organisms; and are offered with a view to prove that the specific markings of any given form are definitely impressed upon it, either at the period when division is completed, or almost immediately afterwards; and that whatever may be the normal shape of these markings—that is to say, their primary form in the young valve—being disposed in a determinate order with relation to each other, and to the boundaries of the frustule, their ultimate configuration is determined, in a principal

degree, by the form of the frustule, and by the direction in which that form exercises a constrictive force, whilst the siliceous material of its valves is still in a plastic condition.

If we admit this proposition, we cannot fail to comprehend how materially the nature of valvular markings may be modified by any variation in the condition to which the parent frustule may be exposed during the period of division; and we at once recognise the futility of drawing specific characters from the mere numerical estimate of striæ within certain limits, or, indeed, from any structural peculiarities apart from such as are constant.

Much of the confusion that exists with regards to the "striation" or "lineation" of the Diatomaceæ arises, I conceive, from the vague manner in which these terms are employed to indicate different portions of the valvular structure. Thus, in *Pleurosigma*, the terms are used, by some writers, to indicate the lines presented to the eye by the coalescence of the several series of intra-linear spaces; whilst, by others, they are intended to denote the lines formed by the boundaries of those spaces. This last is certainly the correct view; and it is borne out by the circumstance that the outline and peculiarities of the intra-linear spaces are determined, as shall presently be shown, by the inherent order of the lineation, and not the lineation by the inherent development of the spaces.

In the 'Synopsis of British Diatomaceæ,' the valve of *Pleurosigma* is stated as being "striated; striæ resolvable into dots, which are frequently hexagonal." Other writers are also in the habit of alluding to "striæ composed of dots." From this definition it is impossible to gather whether the lines we observe crossing each other at certain angles are indicated, or the spaces bounded by the intersections of those lines. In reckoning the number of lines in the one-thousandth part of an inch, the measurements are evidently derived from the first of these points; whereas it is undeniable that the so-called "dots" occupy the intra-linear spaces. The number of "dots," and the number of "striæ," therefore, can never tally; and, for a similar reason, it involves a contradiction to say that the "striæ are resolvable into dots." It remains still a point of dispute whether the intra-linear spaces are depressions or elevations. It is not improbable that they are elevations in some species, and depressions in others. Fortunately, however, the solution of the question is a matter of no great moment for purposes of classification; and it becomes of still less importance when we bear in mind, that as a valve happens

to be viewed in one or other of its aspects, so must the appearance of elevations or depressions vary. At present, it is only in some of the more boldly-marked species that we can decidedly pronounce which surface of a valve is directed towards the observer. On this account I have adopted the use of the somewhat vague term, "intra-linear" spaces, to designate those portions in which the appearances of elevations or depressions occur, leaving the peculiar nature of such spaces to be dealt with in each separate case.

If we examine the valve of any of the most boldly-marked species belonging to the Naviculoid group of diatoms, as, for example, *Pinnularia distans*, *alpina*, or *lata*, we meet with what I conceive to be the simplest form of lineation, namely, a series of narrow, elongated, depressed "costæ,"—as they are very inappropriately termed,—arranged in transverse order on the surface of the valve, and rendered remarkably distinct by their superior degree of translucence, and the contrast they present in refractive power with the adjacent parts. Neither the depressed "costæ" nor the intra-costal spaces exhibit any trace of secondary markings. In proof of the "costæ" being depressions, it may be mentioned that, whilst the median line and nodule and the entire margin of the valves exhibit one uniform colour, usually a pale rose pink, the "costæ" partake of the faint-blue tint observable in the surrounding field of vision; and lastly, that, in accidentally fractured valves, the intra-costal spaces are left more or less entire, like the teeth of a comb, attached to the median portion of the valve, which is precisely the opposite of what would occur did the intra-costal bars constitute the thinnest portions of the valve, whilst the costæ are the thickest.

In the genus *Navicula*, we find this kind of structure modified, but in a slight degree; and this, it appears to me, has not been clearly shown heretofore, inasmuch as the very term "striæ," which is specially employed to indicate the structure, at once suggests the idea of projecting lines, or bands minutely scored across, at intervals; whereas the difference between the markings in *Pinnularia* and *Navicula* consists only in the depressed spaces in the latter genus being so minute as to admit of their arrangement, at intervals, in linear series across the valve, and thus appearing as unbroken lines under the lower powers of the microscope. In this instance, the definition, "resolvable into circular dots," is strictly accurate.

In the monstrosity which has been dignified with the name of "*Surirella craticula*," we at times meet with the

striation of *Navicula*, and the canaliculate structure of *Surirella*, associated on distinct portions of the same valve. In a specimen in my possession, from Bengal, and a similar one from the Channel Islands, the central third of the valve is distinctly striated, whereas the two outer thirds exhibit the canaliculate character, in respect of which this form has been referred to *Surirella*. In vol. ii, p. 97, of the 'Journal of the Microscopical Society,' Professor Gregory has described a similar form as occurring in the "Mull deposit;" and alludes to the so-called "canaliculi" being "bars." Under my view of the structure in *Pinnularia*, to which genus the diatom in question bears much closer resemblance than to *Surirella*, the spaces between the bars are the analogues of the "costæ," whilst the bars constitute the intra-costal spaces. I would here beg leave to state that, in retaining the term "costæ," as ordinarily applied, which is much more applicable to the intra-costal spaces than to the parts which have hitherto received it, I am guided solely by the desire of avoiding inconvenience invariably attendant on changes of the kind.

In *Pleurosigma*, on the other hand, the intra-linear spaces constitute the strongest portions of the valvular plate. In *P. formosum* there exists good evidence to prove that the intra-linear spaces are occupied by elevated rhomboidal papillæ, which present facetted surfaces; whereas in *P. Balticum*, instead of rhomboidal elevations, we have four-sided flattened pyramids, presenting, as in the former case, four sets of lines, of which those bounding the spaces, and not those crossing them, are the predominant ones.

Again, taking into consideration the secondary internal valvular plate, the existence of which is constantly seen in some species, it is not improbable that such a structure may occur throughout the whole family, although incapable of separation in most examples. From the modified impress of the markings of the external plate found upon that beneath it—as, for example, in *Cocconcis*—it is clear that, to a certain extent at all events, the markings of the external surface of the primary plate are traceable on its internal aspect. Much additional evidence must, however, be forthcoming, before this question can be satisfactorily settled.

A good deal of misconception has arisen from the supposed analogy between the markings in *Triceratium*, in which hexagonal structure really occurs, and those in *Pleurosigma*, in which the appearance of hexagonal cellulation is only observable under deceptive instrumental adjustments. In the one case, the hexagonal spaces constitute the thinnest

portion of the valve, and fracture takes place through their centres; whilst in *Pleurosigma*, the intra-linear spaces, which are held, but erroneously, to be equivalent to the hexagonal spots, constitute the strongest portion of the valve, and fracture never takes place through them, save when undue force happens to be employed. That the error in this case originates in a misconceived analogy, is evident from the subjoined quotation:—"The valve is thinner and weaker at the parts occupied by the dots; so that the line of fracture corresponds to these parts." And again—"In those (*Pleurosigmas*) requiring the use of oblique light and stops, the line of fracture also corresponds to the rows of dots, provided the light is equally oblique on all sides; and the same appearances are presented by the dots in both cases, beginning with those in which they are large (as *Isthmia*), to those of moderate size (as in the species of *Coscinodiscus*), down to those in which they are extremely minute (as in *Gyrosigma*, &c.). Moreover, analogy affords us very strong confirmatory ground; for the Diatomaceæ form a very natural family, and if the dots are depressions in some genera, we might expect them to be so in others. Had these dots (in *Gyrosigma*) represented elevations, the valve would have been stronger at those points." ('Micrographic Dict.,' new ed., p. 34.)

If we take into consideration the outline of the more marked discoidal forms, for instance, *Triceratium* and *Coscinodiscus*, and contrast it with that of the Naviculoid group, such as *Navicula* or *Pleurosigma*, it appears to me that we might naturally expect to find the markings in the two types exhibiting some distinct relation to the outline. Now, in the genera which exhibit the honeycomb structure—that is, where we find the appearance of a number of little hollow cylinders, of considerable relative depth, and open outwardly in so far as the siliceous wall is concerned—the conversion of elementary circular cavities into hexagons is exactly what would result from pressure exerted equally in every direction. In a small but well-marked species of *Coscinodiscus*, *C. nitidus*, Greg., the markings are always circular, the distance between them being too great to admit of their shape being modified by the pressure of each cellule upon those adjoining it. The same holds good of a small *Triceratium*, closely allied to Mr. Brightwell's *T. punctatum*.

In *Isthmia* we meet with shallow cellules, or rather depressions, varying in different frustules, in different gatherings, and in different parts of the same valve, from irregular circles, to irregular hexagons, parallelograms, and pentagons, accord-

ing as they are situated on plane or curved portions of the valve; thus proving most clearly, that the figure of the cellules is modified, as I have asserted, by the configuration of the entire frustule.

Advancing from the discoidal group, presenting haxagonal cellulation, we are gradually led, first through *Campylodiscus*, and then *Surirella*, to the Naviculoid group, exhibiting what is called "striation."

In *Campylodiscus cribrosus* we meet with circular or subcircular markings. In *C. Hodgsonii*, the circular and the canaliculate are combined, or rather occur at definite portions of the valvular surface; the canaliculi being arrayed conformably to the curvature of the valve. This last feature is to be seen still more markedly in *C. spiralis*, whilst in *Surirella fastuosa* we have the connecting bond between *Campylodiscus* and the Naviculoid forms; specimens of *C. fastuosa*, from the Channel Islands, presenting a distinct flexure at right angles to the true axis of the valve, as in the last-named genus.

Although our knowledge of the precise share taken in the secretion of the siliceous valve, by the primordial utricle, is lamentably deficient, certain facts crop out, here and there, which it may be well to record under one head, with a view to facilitate further inquiry. We know, for instance, that the frustules of the Diatomaceæ, like the fronds of the Desmidiaceæ are encased in a gelatinous layer or envelope. In some genera, this envelope is highly developed; in others it is not so. But from the invarible obscurity of the markings upon all, until the siliceous surface is cleaned by the application of acids or heat, it is certain that such envelope exists indiscriminately in the whole tribe. Judging, therefore, from the impermeable character of the siliceous wall, it is highly probable that the gelatinous stratum is secreted by the primordial utricle, through the marginal aperture of the valve, much in the same way as the epiderm of the molluscous shell is secreted at the margin of the mantle. Like the latter, moreover, it is probably intended as a protection to the subjacent structure. Of its highly elastic nature we have ample proof, as was shown in a paper communicated by me to this Society a short time ago. We can hardly doubt its vitality, therefore; and we are thus furnished with presumptive evidence that the invisibility of the motile filaments, whose existence I endeavoured to demonstrate inferentially, is due to the same cause that enables this gelatinous stratum to defy our optical appliances.

Another element of difficulty in the resolution of valvular

structure consists in a portion of the connecting zone being sometimes projected under the surface of the valve, and faintly impressed with its markings, as we find to be the case in *Epithemia gibba*, *Stauroneis pulchella*, and *Nitzschia spectabilis*. In *Stauroneis pulchella* and *Cocconeis placentula*, the peculiar wavy appearance which is superadded to the valvular structure would appear to be due to this cause.

I cannot better describe the markings on the valves of *Pleurosigma formosum* and *P. Balticum*, than by comparison of what is seen in the first to a wafer-stamp, or neck of a gun-stock; whereas, in the last, we have the form of marking that would result, were an impression taken of a wafer-stamp, in which the rhomboidal figures were replaced by flattened four-sided pyramids. In both cases there are four facets, inclined at a moderate angle to the plane of the surface; and two of the four sets of lines they exhibit can be brought into focus more readily than the other two. The reason of this is obvious. The diagonal series in *P. formosum*, and the rectangular in *P. Balticum*, being arranged strictly on the same plane, are capable of being brought into accurate focus simultaneously. They constitute the thinnest portions of the valves. Whereas the longitudinal and transverse series in the first species, and the diagonal in the last, being constructed of a series of short zigzags following the rise and fall of the facetted portions, cannot be brought into focus at all points with equal exactness; and form the thickest portions of the valve. The distance, moreover, between the several sets of lines being different, the closer series are more difficult of resolution. The first-named cause is, however, by far the most powerful.

Without taking upon myself the unnecessary task of proving a negative, I would briefly state my reasons *seriatim* for rejecting, as wholly inconclusive, the arguments cited in proof of the hexagonal structure of *Pleurosigma angulatum*, and also the evidence based upon the photographic representation.

The analogy derived from what is seen in *Triceratium* and *Isthmia* has been shown to be fallacious.

It is admitted by the advocates of the hexagonal structure that, under imperfect adjustments of the microscope, "hexagonal dots" may be made to appear quadrangular or triangular; and that those dots which cannot be conceived to be really hexagonal may be made to appear so.

In *Pleurosigma Balticum* or *P. hippocampus*, by imperfect adjustments, the appearance of hexagonal structure may be produced quite as vividly as it can be made to appear in *P. angulatum*.

Inasmuch as the photographic representation so constantly appealed to is stated to be partly in perfect focus, and partly out of focus, whereas the structure is equally distinct on both parts, and the only difference observable consists in the reversal of the lights and shadows, it is much more probable that one portion was as much without the true focus as the other portion was within it.

From the woodcut of the photographic picture, it would appear that the thickness of the walls of the hexagonal cellules is equal to half of their diameter. Now, the striæ being stated to be composed of dots, and the lines being estimated at $\frac{1}{30000}$th of an inch apart, the walls must measure in round numbers $\frac{1}{100000}$th part of an inch in thickness; thus presenting a surface the outline of which ought to be readily resolved by the same powers that show the diagonal markings, —for instance, by a quarter-inch objective,—did the hexagonal structure really exist.

It is highly improbable that hexagonal structure should present itself in one species or group of a well-marked genus, whilst a totally different structure is admitted to exist in the other species of the same genus.

In proof of the rhomboidal structure, I beg, on the other hand, to offer the subjoined proofs.

Under the application of any powers, ranging from $\frac{1}{4}$ to $\frac{1}{12}$ of an inch focus, so long as definition remains unimpaired, the rhomboidal structure is invariably discernible; the diagonal lines being predominant and visible, with perfect clearness, in the case of the rhomboidally marked group, whereas the rectangular series is so in the other.

The object retained in one position on the stage, when viewed under a given power, say a $\frac{1}{12}$-inch objective and a low eye-piece, exhibits oblique lineation and rhomboidal facetted spaces, with perfect definition; whereas, by replacing the low eye-piece with a high one, and making any alteration of focus demanded by the change, the hexagon-like structure exhibits itself, but with imperfect definition.

By causing the rotation of the slide, containing either the rhomboidally or rectangularly marked forms, at every forty-five degrees a fresh series of lines will predominate, according to the direction of the illuminating rays; each of the four series being, of course, twice repeated in one complete revolution, and the change of series therefore taking place eight times.*

* As the longitudinal and transverse series of lines in the rhomboidal group, and the diagonal series of the rectangular group of *Plenosigmas*, require much more careful adjustment than the predominant series, for

Were the structure hexagonal, these changes could not occur in the foregoing order or number; for, inasmuch as in any hexagonal arrangement only three series of lines are present, being disposed on the same plane, the changes to the predominant series would take place six times only, namely, at every 60° in a complete revolution, each series being twice repeated.

It has been pointed out by Mr. Hunt ('Journal of Microscopical Science,' vol. i, p. 175) that the boundaries of a portion of a valve, belonging to one of the diagonally marked group, to which moisture had accidentally gained access, were in strict accordance with the view of diagonal lineation; whereas they were not reconcilable with any other view of the structure. A similar fact may, at any time, be witnessed in balsam-mounted specimens to which air has gained partial access, or in dry mounted slides, affected by the ordinary atmospheric moisture.

Lastly, the lines of fracture, as before stated, invariably tally with the thinnest portions of the valves in the two groups, that is, with the diagonal series in the one, and with the longitudinal and transverse series in the other; a result at variance with the indefinite lines of fracture observable in true hexagonal structures.

Without reverting, then, to theoretical points, I would sum up the general conclusions for which I conceive sufficient evidence has been adduced. They are as follows:—

That the growth of the diatom valve ceases entirely, either at the period of its liberation from the connecting zone of the parent valve, or immediately afterwards.

That, subsequently to this period, no change of configuration takes place in the siliceous valve, except along its margin, where fresh siliceous secretion may, under certain conditions, be produced.

That the normal figure of all markings whatever is circular, or approaching thereto.

That these markings are arranged on the surface of the diatom valve in a determinate order, according to the inherent tendency of the species; but that the ultimate figure of those markings is due to forces exerted upon the young valve, whilst in a plastic condition, and retained within the connecting zone of the parent frustule.

And lastly, that variation in size, and in the degree of fine-

reasons already given, they may be left out of the proof, if the experimenter desires, without in any degree vitiating the result; for, in this case, the change to the predominant series only, would occur four times, instead of eight, in a complete revolution, namely, at each 90°.

ness or coarseness of the markings, is, within given limits, dependent on the conditions under which the sporangeal frustule gives egress to the germs of the new generation; but that the ordinary process of division is, of itself, sufficient to bring about great variation, when operating through a vast succession of individuals.*

* In the discussion which followed the reading of Dr. Wallich's paper, Mr. Wenham stated that, with an object-glass of his own construction, having a focal distance of about $\frac{1}{10}$th of an inch and a large aperture, he had ascertained beyond doubt, that in *Pleurosigma angulatum*, and some others, the valves are composed wholly of spherical particles of silex, possessing high refractive properties. And he showed how all the various optical appearances in the valves of the Diatomaceæ might be reconciled with the supposition that their structure was universally the same.—[*Eds.*]

TRANSACTIONS.

Remarks on some Diatomaceæ, new *or* imperfectly described, *and a* new Desmid. By Tuffen West, F.L.S.

The object of the present remarks is to bring before the members of the Microscopical Society some two or three Algæ with which I have been favoured by the kindness of correspondents; I shall also add a few particulars to the descriptions of forms already known, and shall suggest some corrections in the published notices of others.

In working over numerous slides of Diatomaceæ, belonging to Mr. T. Brightwell, of Norwich, I made sketches of the following Triceratia, which were reserved till such time as sufficient material had accumulated for another of his valuable papers on this genus. Being unable to continue his labours in this field, he has cordially acceded to the request that I might be permitted to publish them for him.

1. Triceratium.

T. parmula, Br. Four-sided variety. (Pl. VII, fig. 1.)

With the instances now known of variation in the number of sides in species belonging to this genus, accumulated by Mr. Brightwell, Dr. Wallich, and others, little room can remain for the doubt expressed by the late Professor Bailey, as to the possibility of such an occurrence. The specimen figured occurred in a gathering from the Mauritius.

T. venosum, Br. (Fig. 2.)

Angles slightly elevated above the general surface of the valve, not produced into horns, truncate; puncta and canaliculi not reaching the apposed edges of the valves, but leaving a broad hyaline margin, free from markings of any kind; cingulum —— ?

T. castellatum, n. sp. (Fig. 3.)

Sides of the frustule deeply concave, separated by siliceous lines from the central portion; angles forming segments of circles. On front view the angles form dome-shaped emi-

nences; surface uniformly punctate, with a single row of larger puncta along the apposed margins. Cingulum covered with fine, regularly decussating puncta. Length of valve, from central point of one angle to that of another, ·0025."

In Barbadoes earth, very rare.

This species approaches *Tr. venosum*, Br., *Tr. coniferum*, Br., and *Tr. trisulcum*, Bailey. From the former it is separated by the absence of the conspicuous lines; from *T. coniferum* by the concave sides, the obtuse angles, the lines separating these from the body of the valves, and by the absence of spines; from *T. trisulcum*, by the circular form of the angles, and the regular and close punctation. It is a robust and well-characterized form; the discovery of further examples may be expected to repay careful search in the rich material that yielded the present one. Each obtusely rounded angle, on front view, bears a not inapt resemblance to a lady's thimble, with its regular rows of diagonally arranged depressions.

T. marginatum, Br. (Fig. 4.)

Front view; valve very shallow, much depressed in the centre, elevated at the angles into short truncate horns; margin of valve with a delicate ala, unto which the puncta and canaliculi are continued; apposed edges broadly free from markings, as in the last; cingulum —— ?

The various aspects of the three above-mentioned forms were obtained by moving the specimens about by gentle pressure on the covering glass, the balsam, of course, not having been hardened; this plan may be strongly recommended when examinations are made of material in which fine forms occur but sparingly.

The two species of Triceratium not having been fully described, I am induced to make the following remarks, with the hope of rescuing them from the confusion in which they are enveloped, some excellent observers still classing them as varieties of one and the same species.

T. intricatum, T. W. (Fig. 5.)

"Valve with acute angles," centre tumid, angles slightly produced; "cellular structure faintly discernible;" an apparent pseudo-nodule due to a short central spine; margins of frustules undulated, commonly presenting an end view, united in distant series to form a filament.

This species was described and figured in the first volume of the 'Synopsis of the British Diatomaceæ,' as *T. striolatum?* Ehr. When it was ascertained that it was not that species, the form of the margins readily suggested the name "undulatum;" but that it is not the "undulatum" of Ehrenberg. I think certain, though to separate them by description is

difficult. Ehrenberg's species occurs in the Bermuda deposit, which contains only strongly siliceous forms, has no "pseudo-nodule," and is, I believe, perfectly plane on the surface. Mr. Brightwell first announced the true nature of the so-called "pseudo-nodule," and the occurrence of frustules attached in filaments in this condition. I have pleasure in being able to show an original drawing by Lieut.-Col. Baddeley, of Cliff Cottage, Gorlestone, who has had extended opportunities for investigating this and the following species, which he has taken great pains to clear up.

T. Brightwellii, T. W. (Fig. 6.)

Central spine of great length, with a fringe of obtuse spines round the margins of the valve.

This species, well characterized by the extraordinary length of the central spine, which is throughout of equal thickness, and the remarkable fringe around the margins of the valve, cannot have a more appropriate name than that of him who might almost be called the author of the genus. In addition to the Gorlestone habitat, it has been found at Teignmouth. From the delicacy of the cingulum, and the great distance to which the frustules are pushed by the development of the spines, it is probable that they are generally solitary and never form a lengthened filament. Mr. Brightwell, fig. 2, Pl. VIII, ('Micr. Journ.,' vol. vi), represents *T. intricatum*, T. W., two frustules attached; his fig. 1, a side view of *T. Brightwellii*, with the inflated lateral margins (the coronet of spines has been overlooked by the draughtsman); fig. 4 of the same plate represents the front view of two frustules of *T. Brightwellii*, after recent subdivision, attached by the connecting membrane; fig. 3, the same shortly before the occurrence of subdivision; fig. 5, a four-sided frustule, the upper valve presents a nearly complete side view, the central body within the connecting membrane shows the two new half-frustules forming in the early stage of subdivision, now detached from their proper position, and free within the connecting membrane.

T. variabile, Br. Front view. (Fig. 7)

The front view of this species only differs from that of its nearest ally, *T. alternans*, in the possession of a greater number of strong siliceous lines.

2. Asterionella, *Hass.*

A. formosa. Hass. (Fig. 8.)

Side view linear, inflated towards the base, capitate at both ends, the lower (attached) extremity the larger; numerous frustules occasionally adhere, and then form a flat-spiral, like *Meridion circulare*.

All the species of Asterionella at present known are extremely hyaline, almost disappearing in balsam; on *A. formosa*, dry, I have, with high powers, seen faint indications of striæ. The present species will probably prove to be far from uncommon; it has been found at Tenby, Harrogate, Norwich (for specimens from the two latter places I am indebted to Mr. F. Kitton), and in the neighbourhood of London. A curious fact connected with it is its discovery first in the waters supplied to these various places for drinking purposes. Dr. Hassall informs me that at certain seasons it is one of the commonest of the Diatomaceæ occurring to him in his examinations of London waters; and Dr. Lankester's experience goes to confirm this. When growing freely under favorable circumstances, numerous frustules may adhere together; I have seen it from the Serpentine in this state—sixteen, twenty, and more, were not uncommonly united. I believe it is always free, or unattached.

A. Ralfsii, W. Sm. (Fig. 9.)

This species approaches nearest to Diatoma. I have seldom seen more than four or six in a star. It was gathered plentifully by Mr. Ralfs, for two years, in a little boggy pool at the base of Cader Idris, and I have seen it in a gathering of Diatomaceæ from Teignmouth.

A. Bleakleyii, W. Sm. (Fig. 10.)

Side view as in *A. formosa*, the attached extremity larger than in that species.

By courtesy of Dr. J. E. Gray, I have had the opportunity of examining authentic specimens of this species in the collection at the British Museum. As many as sixteen or twenty frustules occasionally occur in union. Whilst on a visit to Colonel Baddeley, I had the pleasure of seeing, in a living state, numerous examples obtained from *Noctiluca*, which differed in the great inflation of the attached extremities, and the extreme slenderness of the frustule both on front and side view. I am unwilling, however, to consider this as more than a variety of the present species; it was gathered by the late Mr. W. Brooks, at Walton-on-the-Naze.

3. Podosira, *Ehr.*

P. ? compressa, n. sp., T. W. (Fig. 11.)

Frustules geminate, polar always much shorter than the equatorial diameter; valves elliptic, indistinctly marked with scattered puncta; cingulum smooth. Breadth of long diameter of valve, ·0008″ to ·0014″; of short diameter, ·0004″ to ·0005″.

This interesting form has, I believe, only been met with as yet on the coast of Northumberland, where it was found by

Mr. Thomas Atthey, of West Cramlington, along shallow sand ripples in Druridge Bay, and subsequently on Cresswell Sands, where it has also been observed by the Rev. Robert Taylor. It occurs plentifully, never more than in pairs of frustules, always free, on the sands, and is, when dry, of a clear-brown colour. In deference to the opinion of my friend, Mr. Roper, I have placed this provisionally in the genus *Podosira*, though I cannot but think it has little right to be there, and that it should constitute a new genus; the compressed valves, entire absence of stipes or attachment of any kind during growth, and want of thickened umbilicus, furnishing valid grounds for such separation. Perhaps *Coscinodiscus ? ovalis*, and some other oval and elliptic forms, might be associated together to form such proposed new genus.

4. Chætoceros, *Ehr.*

C. armatum, n. sp.

Filament compressed; frustules quadrangular, with the angles excavated, imperfectly siliceous, covered with a mucous investment; from each angle arises a long, obtuse, curved seta, with some acute ones at its base; valve elliptical; breadth of long diameter, ·0013″ to ·0032″; of short diameter, ·0005″ to ·0008″. (Fig. 12.)

Found by Mr. Glasspoole, on the Norfolk Coast, near Ormesby, in 1857, and communicated to me by Lieut.-Col. Baddeley, in the living state; since then, abundantly on various parts of the coast. Filaments short, usually of six to ten frustules; on one occasion only have I seen a lengthened filament of thirty frustules.

Doubts have been expressed as to the true nature of this organism, which will be dispelled by more careful examination; the endochrome, structure of the valves, and mode of increase by self-division are purely diatomaceous. As to the entire absence, or nearly so, of silica in its composition, I have long maintained that too great stress must not be laid on this circumstance; it would not be difficult to name species admitted by the most rigid systematists, which totally disappear on treatment with nitric acid. I am glad to find my views confirmed by a valued friend, from whose letter the following remarks are quoted, expressing as they do so nearly my own views.

He says, "I have never altered my opinion that eventually the *disposition* and *colour* of the endochrome will be found the true way of solving to what species or varieties diatoms belong, and not alone the markings on their siliceous envelopes, as at present held. I believe further, that there is not a diatom with green endochrome, and also that we insist too

much on a *strong* siliceous envelope being necessary to constitute a diatom. I believe, on the contrary, that the frustule may have very little silex, but that the colour and disposition of the endochrome furnish the only true grounds for classifying it."

The filament is always enveloped in a thick covering of tenacious mucus, which renders its satisfactory examination difficult. That this is an integral portion of it I am led to believe by the fact, in the first place, of its being always present; and in the second, that when a frustule is found clear from it, as occasionally happens at the end of a filament, the endochrome is dead, and has more or less completely disappeared.

C. boreale, Bail.

The discovery by Mr. Atthey, on the Northumbrian coast, in the stomach of *Modiola vulgaris*, of this species, makes an interesting addition to our list of British Diatomaceæ, its recorded habitats having hitherto been on the American coast, and in the Indian Ocean, supposing *C. Peruvianum* to be the same thing, which is not yet clearly proved. The direction of the horns at right angles to the frustule in many of the British specimens (fig. 13) is a curious circumstance. Along with it occurred *Doryphora amphiceros* and other commoner marine Diatomaceæ, with the doubtful *Actiniscus Sirius*, Ehr. (fig. 14), and some specimens of *Polycystineæ*.

5. ATTHEYA, nov. gen., *T. W.*

Frustules quadrangular, compressed, annulate; annuli indefinite; valve elliptical lanceolate, with a median line; a spinous process from each angle.

A. decora, n. sp. T. W. (Fig. 15.)

Annuli 12 to 28, 20 in ·001; septa alternate. Width of frustule, ·0009″ to ·0015″. Breadth of valve, ·0003″, with a median line and distinct central punctum.

Found by Mr. Atthey, plentifully on Cresswell Sands, in June, 1859, free from admixture; and again equally clean in May of the present year. Also with *Podosira? compressa*, and other diatoms of similar habitat, by the Rev. R. Taylor and Mr. Atthey, in the same place, and by the latter in Druridge Bay. The appearance of this pretty little species is precisely like *Striatella unipunctata* in miniature, the arrangement of the endochrome being also much the same in both; from *Striatella*, however, it is separated by the presence of spinous processes at the angles, and the entire absence of stripes or attachment of any kind. Of the propriety of in-

stituting a new genus for it there can be no question, and I have much pleasure in dedicating it to Mr. Atthey, a very acute and diligent observer. It is not so easy to decide on its true place in a natural system; for it appears to unite *Striatella* with *Chætoceros*, next to which latter I feel disposed to place it, on account of the spinous processes at the angles; and the discovery of the structure of *Rhizosolenia*, a near ally, in which I ascertained the existence of indeterminate alternately-arranged annuli, seems to diminish the difficulty that might otherwise be felt in allying it with *Chætoceros*.

6. Closterium, *Nitzsch.*

C. aciculare, n. sp.

Frond elongated, very slender, straight except at the extremities, which are very slightly curved downwards, gradually tapering from the centre to the very acute ends. Length of frond, $\frac{1}{3}\frac{1}{0}$th of an inch; greatest breadth, $\frac{1}{3}\frac{1}{0}\frac{1}{0}\frac{1}{0}$th. (Fig. 16.)

This form does not agree with any species of *Closterium* given by Mr. Ralfs; from *C. juncidum*, to which it approaches, it differs in the gradual tapering from the centre to the very slender produced ends. Mr. W. Archer, of Dublin, has kindly sent me tracings of some slender *Closteria*, figured by De Brébisson, with a note, from which I extract the following:—

"It is far longer in proportion to its width than any *Closterium* I have ever seen, either living or figured. Is the empty frond smooth or striated? Are the striæ close and fine or coarse? Its great length and slight breadth bring it near *C. prælongum* (Bréb.), but in that species the ends are slightly turned upwards; in *that* respect, like *C. turgidum*, yours look downwards, rather. Its general outline more approaches *C. macilentum* (Bréb), which is, however, little more than half as long as yours *in proportion to its width*. Both those species are smooth, *i. e.*, without striæ. Has Mr. Atthey seen its conjugated state? In *C. macilentum* the empty frond remains attached to the sporangium for some time; conjugation takes place soon after self-division, so that one empty segment of each old frond is much longer than the other."

In reply to these questions, though sporangia have been found with it, their connexion has not yet been traced, and the empty frond is non-striate. It was found by Mr. Atthey in abundance on Prestwick Carr, Northumberland, a noted place for these organisms, which, however, there is too much reason to fear, have now entirely disappeared from it, owing to the drainage of the spot.

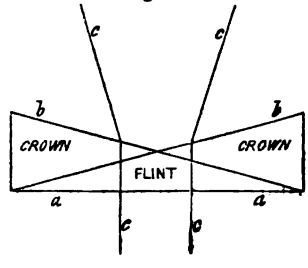
On an Improved Binocular Microscope.

By F. H. Wenham.

(Read June 13th, 1860.)

In a paper read by me before the Microscopical Society, in May, 1853, and published in Vol. II of the 'Transactions,' I described several arrangements for obtaining binocular vision with the microscope, and stated that I had obtained *the best definition* by means of an achromatic prism, shown by fig. 1. *aa* is a prism of flint-glass; *bb* two separate prisms of crown-glass, cemented thereon; *cc* is a ray of light, incident on the flat surface of the flint prism. At its final emergence from the crown, it is refracted *outwards*, without colour or distortion, in the direction shown. If this compound prism is placed behind an object-glass with the line of junction coincident with the optic axis, it will separate the pencil of rays emanating from the object, and give two images—that obtained from the right and left-hand half being brought respectively into each eye on the *same* side.

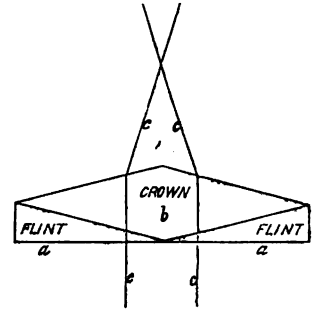
Fig. 1.



In Dr. Carpenter's 'Manual of the Microscope,' the faults of this instrument are thus stated precisely: "This, too, was far from being satisfactory in its performance, having two capital defects; namely, first, that the view that it gave was often *pseudoscopic*, the projecting portions of the object appearing to be depressed, and *vice versa*. And, second, that the two bodies being *united* at a fixed angle of convergence, the distance between their axes could not be conveniently adapted to the varying distances of the eyes of different individuals." I have since entirely removed these causes of objection, by slight modifications not detracting from the original simplicity of the instrument. When two stereoscopic pictures are accidentally so mounted as to give a *pseudoscopic* effect, the remedy is to transpose them. For a similar reason, I have transposed the images in my former binocular microscope, by refracting them so as to cross each other immediately behind the object-glass, bringing the right-hand system of rays into the *left* eye, and *vice versa*. Fig. 2 illustrates the mode of accomplishing this: *aa* are two prisms of flint-glass, cemented to a single four-sided prism, *b*, of crown-glass. A ray of light, *cc*, incident on the surface of the flint

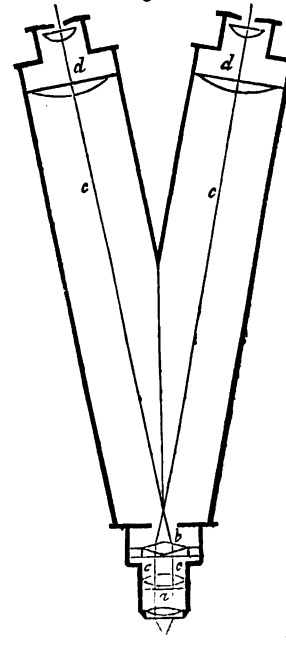
prisms, on its final emergence from the crown, is refracted *inwards* instead of outwards, as in the former prism (of which this is the converse), and the right and left-hand images from the object-glass cross each other to the opposite eye, invariably giving a true orthoscopic effect. The dispersive power of the prisms must be balanced, to obtain freedom from colour; and the degree of refraction such as to throw the image of a particle, *exactly* into the centre of each eye-piece.

Fig. 2.



The second defect has also been overcome in the following manner. The two bodies are still permanently held at one fixed angle of convergence towards the object-glass; but the angle has been diminished to somewhat less than that described in my first instrument, so as to bring the eye-pieces nearer together to meet the requirements of those whose eyes are set in more than usual proximity. The two bodies are furnished with draw-tubes, by lengthening which the distance between the two eye-pieces is increased to suit the eyesight of persons whose vision is far apart. By drawing out the tubes two inches, I can vary the transverse distance from $2\frac{1}{8}$ to $2\frac{3}{4}$ inches, which range is amply sufficient for all variations of ocular position; and the tubes being elongated in the line of each axis, an object always maintains its position in the centre of the field. Fig. 3 represents the outline of the binocular microscope: *a a*, object-glass; *b*, prism; *c c*, rays from object-glass crossing over to opposite sides on leaving the prism; *d d*, eye-pieces.

Fig. 3.



In conclusion, I may state that the *thinness* of the achromatic refracting prism gives it a great advantage in the

quality of definition over the double system of reflecting prisms that has been proposed; the *greatest* thickness of glass that the rays have to pass through being only ·096 or less than *one tenth* of an inch. The drawback to the adoption of the prism I have described is the great difficulty attendant upon its construction.

The binocular microscope, in its principle to the present time, however carefully constructed, gives but little reason for expecting any particular discovery to result from its aid, as it fails in giving a distinct definition of test objects under the highest powers, and must ever fail in this particular, while only *one half* the object-glass is used in producing each image. With low powers, however, on objects having an appreciable thickness, its performance is sufficiently satisfactory. In the instrument I now exhibit, all the adjustments being *fixed*, it is not liable to get out of order, and will bear as much rough usage as any microscope. The double body can be fitted to any of the ordinary forms of microscope-stand.

List of DIATOMACEÆ *occurring in the neighbourhood of* HULL.

By GEORGE NORMAN, Esq., Hull.

(Continued from page 71.)

PINNULARIA, Ehrenberg.

P. nobilis, Ehr.—In fresh-water ditches not common. Ditch Cottingham. Road. Peat Deposit, Hornsea.

P. major, Sm.—Frequent in fresh-water ditches. Harrogate. Hornsea Peat Deposit. Market Weighton Canal. Spring Ditch.

P. viridis, Sm.—Very frequent in fresh water. Spring Ditch. Cottingham. Saltersgate. Nettleton. Skirlaugh. Driffield. Reservoir Waterworks. Haltenprice. Hornsea Deposit. Beverley.

P. oblonga, Sm.—Frequent in fresh water. Cottingham. Spring Ditch. Skirlaugh. Hornsea Deposit. Pure in Springs near Cottingham.

P. cardinalis, Ehr.—Not unfrequent in the Hornsea Peat Deposit.

P. distans, Sm.—Very frequent in Ascidians. Sands at Hornsea. Dredgings off Flambro' Head.

P. peregrina, Ehr.—Very frequent in brackish water. Stone-ferry. Tetney. Humber Banks, very frequent. Copious and nearly pure in a ditch near River Hull, above Stone-ferry.

P. acuta, Sm.—Very frequent in fresh water. Cottingham. Pond at Skirlaugh. Risby Pond. Driffield. Wawne. Market Weighton Canal. Spring Ditch. Beverley.

P. directa, Sm.—Local. Frequent in a salt-water gathering, Grimsby.

P. radiosa, Sm.—Very frequent in fresh and brackish water. River Hull, pure. Cottingham. Pure at Harrogate. Haltenprice. Pure in a Spring, Cottingham. Hornsea Peat Deposit. Reservoir Waterworks.

P. gracilis, Ehr.—Very frequent in brackish and fresh water. Marfleet. Humber Banks. Pure in a ditch near River Hull. Tetney. Saltersgate. Spring Ditch.

P. viridula, Sm.—Very abundant in fresh water. Wawne. Killinghall. Abundant near Cottingham. Near Stone-ferry. Very pure near "New Village" Cottingham.

P. Cyprinus, Ehr.—Very abundant in salt and brackish water. Dairycoats, under Railway arch. Humber Banks, frequent. Marsh Chapel. Tetney. Grimsby. Very good in a ditch near the River Hull.

P. divergens, Sm.—Rare. Cottingham, near Mr. Harrison's Grounds. Ditch near Springs, Cottingham.

P. stauroneiformis, Sm.—Not unfrequent in fresh water. Copious in a gathering, Skirlaugh. Nettleton. Reservoir Waterworks. Harrogate. Cottingham. Spring Ditch.

P. Johnsonii, Var. β Sm.—Copious in a gathering from the Piers of the Victoria Dock.

P. gibba, Ehr.—Rare in fresh water. Saltersgate. Risby Pond. Cottingham. Haltenprice.

P. Tabellaria, Sm.—Rare. Rocky stream, Saltersgate.

P. mesolepta, Ehr.—Not unfrequent in fresh water. Boggy ditch, Saltersgate. Haltenprice. Hornsea Deposit. Beverley Parks.

P. mesolepta Var. with stauros.—Fresh water. Risby Pond. Harrogate.

P. interrupta, Sm.—Not common. Nettleton. Wawne. Harrogate.

P. interrupta, Sm. *Var.* β.—Rare. Clay Pits, Nettleton.

P. borealis, Ehr.—Rare. Soil from Benningholme Carrs. Market Weighton Canal.

P. hemiptera, Sm.—Rocky stream, Saltersgate.

P. gracillima, Greg.—Rare. In rocky stream, Saltersgate.

P. Polyonca, Bréb.—Very rare. In a pond in the wood at Nettleton.

P. pygmæa, Ehr.—Not unfrequent. Banks of River Hull. Ditch at Cottingham. In a water tub for poultry. Small ditch near River Hull, above Stoneferry. Near the Glass Houses, Dr. Munroe.

P. biceps, Greg.—Rare. Market Weighton Canal.

P. gargánica, Rabenh.—Frequent in fresh and brackish water. Ditch leading from Anlaby to Hessle Road. Humber Banks. Ditch at Cottingham. Harrogate. Ditch near River Hull.

STAURONEIS, Ehrenberg.

S. Phœnicenteron, Ehr.—Common in fresh water. Nettleton. Cottingham. Saltersgate. Nearly pure in a boggy place, Skirlaugh. Risby Pond. Harrogate. Hornsea Deposit. Market Weighton Canal.

S. gracilis, Ehr.—Not uncommon. Near River Hull. Nettleton. Haltenprice. Humber Banks. Spring Ditch. Hornsea Deposit.

S. acuta, Sm.—Rare. Not unfrequent in Risby Pond. Hornsea Peat Deposit.

S. salina, Sm.—Frequent in brackish water. Pure near Stoneferry. Stallingbro'. Marsh Chapel. Tetney. Ditch near River Hull. Outlet Hornsey Meer.

S. dilatata, Sm.—Rare in brackish water. Ditch near River Hull, beyond Stoneferry. Tetney.

S. crucicula. Sm.—Rare in brackish water. River Hull.

S. anceps, Ehr.—Frequent in fresh water, though never abundant. Spring Ditch. Frequent near Cottingham. Beverley. Nettleton, in Clay Pit. Wawne. Harrogate. Haltenprice. Hornsea Deposit.

S. linearis, Ehr.—Frequent in fresh water, though always much mixed. Killinghall. Beverley. Very frequent near Cottingham. Market Weighton Canal.

S. pulchella, Sm.—Very frequent in Ascidians. Hornsea Sands. Dredgings off Flambro' Head.

PLEUROSIGMA, Smith.

P. decorum, Sm.—Rare. Not unfrequent in a Dredging off Flambro' Head.

P. rigidum, Sm.—Rare in a Dredging taken off Flambro' Head. North Humber Bank, Dr. Munroe.

P. elongatum, Sm.—Abundant in salt water. Ditch leading from Anlaby to Hessle Road. Marfleet. Outlet Hornsea Meer. Ditch near River Hull. Tetney.

P. intermedium, Sm.—Not unfrequent in salt water. Victoria Dock Timber Pond. Timber Pond, Grimsby.

P. Nubecula, Sm.—Rare. Timber Pond, Grimsby. Timber Ponds, Victoria Dock.

P. delicatulum, Sm.—Not unfrequent in salt and brackish water. Victoria Dock Timber Ponds. Ditch leading from Stoneferry to Sutton.

P. strigosum, Sm.—Not unfrequent in salt water. Humber Banks, near Paull. Dredgings, Flambro' Head. Grimsby. Humber Banks, Marfleet.

P. quadratum, Sm.—A small variety in abundance under the Railway arch, Dairycoats.

P. angulatum, Sm.—Very frequent and abundant. Humber Banks. Garrison Moat. Dairycoats. Pure in many instances. Outlet Hornsea Meer. Stoneferry. Grimsby, very large.

P. Æstuarii, Sm. ?—Plentiful in a gathering under the Railway arch, Dairycoates. North Humber Bank, Dr. Munroe.

P. Normani, Ralfs=*lanceolatum*, Nor.—Abundant in Ascidian gatherings.

P. lanceolatum, Donk.—Very rare. Sand at Hornsea.

P. acutum, Nor. M. S.—Frequent in Ascidian gatherings.

P. Balticum, Sm.—Very rare. Humber Banks in two instances, but only in odd frustules.

P. scalprum, Bréb.=*Balticum Var.* γ Sm.—Frequent in salt and brackish water. Pure on a stone Jetty near Hessle. Grimsby. River Hull. Humber Banks. Garrison Moat. Ditch near River Hull, above Stoneferry.

P. Strigilis, Sm.—Not unfrequent in salt and brackish water. Pure, Humber Bank, near Marfleet Clough. Ditch near River Hull, beyond Stoneferry. Ditch running from Stoneferry to Sutton.

P. acuminatum, Sm.—Not unfrequent in salt water. Near Grimsby. Stallingbro'. Never abundant.

P. distortum, Sm.—Not common. Salt or brackish water, near Grimsby.

P. Fasciola, Sm.—Very frequent in brackish water. Humber Banks, very frequent and sometimes pure. Garrison Moat, pure. Grimsby, much larger than on the north side of the Humber. Ditch running from Stoneferry to Sutton, pure.

P. macrum, Sm.—Very local. Copious in a brackish ditch running from Stoneferry to Sutton.

P. prolongatum, Sm.—Pool at Grimsby, rare. Not unfrequent in Ascidian gatherings. Victoria Dock Timber Pond, Mr. Robt. Harrison.

P. transversale, Sm.—Rare. In Ascidians.

P. tenuissimum, Sm.—Rare. Not unfrequent in a large pool of salt water near the Dock, Grimsby.

P. littorale, Sm.—Rare.—Mixed with *P. angulatum.* Shores of the Humber, between Grimsby and Stallingbro'.

P. Hippocampus, Sm.—Very frequent in salt and brackish water. Pure on Humber Banks. Garrison Moat. River Hull. Tetney. Ditch near River Hull, above Stoneferry.

P. attenuatum, Sm.—Very abundant in fresh water. Spring Ditch. Pure at Haltenprice. Cottingham. Nettleton. Risby Pond. Newbald. Frequent in Hornsea Peat. Market Weighton Canal. Wawne.

P. attenuatum, Sm. *Var* β.—Frequent in fresh water. Reservoir Waterworks. Wawne, &c.

P. lacustre, Sm.—Abundant in fresh water. River Hull. Cottingham. Risby Pond. Ripley. Harrowgate. Haltenprice. Hornsea Peat. Beverley. Market Weighton Canal.

P. Spencerii, Sm.—Frequent in fresh water. Spring Ditch. Hornsea Meer. Wawne. Risby Pond. Clay Pit, Nettleton, very good. Haltenprice. Hornsea Peat Deposit.

P. Parkerii, Harr.—Copious in a fresh-water gathering from Thornton-le-Moor.

TOXONIDEA, Donkin.

T. insignis, Donk.—Rare in Ascidian gatherings.

T. undulata, Nor. M. S.—Very rare in an Ascidian gathering.

SYNEDRA, Ehrenberg.

S. pulchella, Kütz.—Not common. Salt and brackish water. Humber Banks. Reservoir Waterworks.

S. gracilis, Kütz.—Not unfrequent in brackish ditches. North Humber Bank.

S. acicularis, Sm.—Frequent in salt and brackish water. Humber Banks. Tetney, in large pool of water near the Lock.

S. minutissima, Kütz.—Not common. Frequent in a gathering from a ditch between Newland Toll Bar and Stoneferry. Thornton-le-Moor.

S. salina, Sm.—Rare. Brackish water. Market Weighton Canal.

S. radians. Sm.—Abundant in almost every fresh-water gathering. Spring Ditch. Risby Pond. River Derwent. Cottingham. Newbald. Wawne. Reservoir Waterworks.

S. Ulna, Ehr.—As abundant as the above in fresh water. Spring at Haltenprice. Wawne. River Derwent, at Malton. Reservoir Waterworks. Ripley. Harrogate. Haltenprice. Hornsea Deposit. Beverley.

S. capitata, Ehr.—Frequent in fresh water. Copious in the Spring Ditch. Risby Pond. Reservoir Waterworks. Hornsea Peat, &c.

S. tabulata, Kütz.—Frequent in brackish water. Humber Banks. Pools at Marfleet.

S. affinis, Kütz.—Flambro' Head, on Alga, abundant.

S. hamata, Sm.—Rare. Outlet to Lake Ripley Castle.

S. Arcus, Kütz.—Rare in brackish water. On *Cladophora* salt-water pool, Humber Bank, near Marfleet, copious. Abundant in a ditch, Stoneferry.

S. fasciculata, Kütz.—Rare. Outlet to Lake Ripley.

S. superba, Kütz.—Not frequent. Salt-water pools. Grimsby. Attached to *Cladophora,* Cleethorps. From Coralline, Whitby.

S. Gaillonii, Ehr.—Rare. In a Dredging, Flambro' Head.

S. fulgens, Sm.—Not unfrequent in brackish water. Humber Banks. Cleethorps. Near Marfleet Clough. Abundant near Marsh Chapel.

S. tenera, Sm.—Rare. In a pond at Skirlaugh.

COCCONEMA, Ehrenberg.

C. lanceolatum, Ehr.—Very frequent in fresh water. Spring Ditch. River Hull, Wawne. Nettleton. Risby Pond. Newbald. Driffield. Hornsea Deposit. Pure in a stream, " Birk Craggs," Harrogate.

C. cymbiforme, Ehr.—Not unfrequent in fresh water. Spring Ditch. Newsham Lake. Wall under a leaky tap.

C. Cistula, Ehr.—Frequent in fresh water. Spring Ditch. Beverley. Wawne. Pond, Skirlaugh. Hornsea Deposit.

C. parvum, Sm.—Rare. On a wall under a leaky water-tap. Ditch Anlaby Road, Dr. Munroe.

C. cornutum, Greg.—Rare. In the Reservoir Waterworks.

DORYPHORA, Kützing.

D. Amphiceros, Kütz. Abundant in Ascidians. River Hull. Sparingly in the Reservoir Waterworks, to which salt water occasionally has access. Ditch near the River Hull, beyond Stoneferry.

D. Boeckii, Sm.—Very rare. In a gathering from *Corallina officinalis,* Whitby.

GOMPHONEMA, Agardh.

G. capitatum, Ehr.—Not unfrequent in fresh water. Cottingham. Peat deposit, Hornsea. Anlaby Road, Dr. Munroe.

G. insigne, Greg.—Rare in fresh water. Springs, Newbald.

G. constrictum, Ehr.—Very frequent in fresh water. Pond, Skirlaugh. Risby Pond. Beverley. Anlaby Road. Wawne. Harrogate. Cottingham. Hornsea Deposit. Market Weighton Canal.

G. acuminatum, Ehr.—Frequent in fresh water. Driffield. Newsham Lake. Cottingham. Wawne. Beverley. Reservoir Waterworks.

G. dichotomum, Kütz.—Not unfrequent. Newbald. River Hull, Wawne. Market Weighton Canal.

G. tenellum, Sm.—Not unfreqent in fresh water. Ditch on the Road from Newland Toll Bar to Stoneferry. Driffield. Pond, Skirlaugh. Wall under a leaky tap.

G. olivaceum, Ehr.—Frequent in fresh water. Pure at Benningholme. On *Cladophora* in the Reservoir Waterworks. Cottingham Beck, very good.

G. intricatum, Kütz.—Not unfrequent in fresh water. Pond at Nettleton. Wawne. Ditch running from Anlaby to Hessle Road. River Derwent. Benningholme.

G. Vibrio, Ehr.—Rare. River Hull at Wawne.

G. curvatum, Kütz.—Abundant, in fresh-water gatherings. Pure on *Cladophora*, Cottingham Beck. Reservoir Waterworks. Harrogate, pure.

G. marinum, Sm.—Frequent in marine gatherings. Pure on *Cladophora rupestris*, Filey Bridge and Flambro' Head.

RHIPIDOPHORA, Kützing.

R. abbreviata, Kütz.—Local. Pure on *Alga* in a large pool of salt water near the Dock, Grimsby.

R. tenella, Kütz.—Pure on *Cladophora*, Filey Bridge.

R. paradoxa, Kütz.—In abundance on *Cladophora*, Flambro' Head.

MERIDION. Agardh.

M. circulare, Ag.—Very abundant in clear fresh water. Spring at Haltenprice, copious. Springs at Cottingham. Market Weighton Canal. Very frequent near Cottingham. Very pure and abundant in a spring near the Trout stream at Driffield.

M. "constrictum, Ralfs.—Rare. Spring Ditch," Dr. Munroe.

BACILLARIA, Gmelin.

B. paradoxa, Gmel.—Very abundant in brackish water. Ditch near River Hull, above Stoneferry, abundant. Victoria Dock Timber Pond. Market Weighton Canal. Humber Banks. Copious in a ditch between Stoneferry and Sutton.

HIMANTIDIUM, Ehrenberg.

H. pectinale, Kütz.—Not unfrequent in clear fresh water. Cottingham. Spring at Saltersgate, pure.
H. undulatum, Sm.—Not unfrequent with the above in the Spring at Saltersgate.
H. Arcus, Sm.—Rare. Wawne Ferry.
H. gracile, Ehr.—Rare. In the River Hull.
H. majus, Sm.—Rare. Stream near the Springs, Cottingham.

ODONTIDIUM, Kützing.

O. mutabile, Sm.—Very abundant in fresh clear water. Risby Pond. Wawne. Market Weighton Canal. Abundant near Cottingham. Spring Ditch, copious.
O. Tabellaria, Sm.—Not unfrequent in fresh water. Hornsea Meer. Risby Pond. River Hull at Wawne. Hornsea Peat Deposit.
O. Harrisonii, Sm.—Abundant in fresh water, though generally much mixed. Haltenprice. Spring Head. Hornsea Deposit. Spring Ditch. Abundant near Cottingham, but always much mixed. Quite pure and copious, attached to sand in a bubbling spring near Hull.
O. parasiticum, Sm. — Rare. Market Weighton Canal. Beverley Parks, near Woodmancy.

DENTICULA, Kützing.

D. tenuis, Kütz.—Rare. In the River Hull, Wawne Ferry. Anlaby Road, Dr. Munroe.
D. inflata, Sm.—Not unfrequent in a spring near Newbald.
D. sinuata, Sm.—Rare. Cottingham, in a stream near the springs. Ditch in Beverley Parks, near Woodmancy.

FRAGILLARIA, Lyngbye.

F. capucina, Desm.—Frequent in fresh-water ditches. Inglemire Lane. Wall under a leaky tap. Cottingham, &c.
F. virescens, Ralfs.—Frequent in fresh-water ditches. Cottingham. Wawne. Inglemire Lane.

F. striatula, Lyng.—Abundant on *Cladophora* on the Rocks, Flambro' Head. Filey Bridge.

EUCAMPIA, Ehrenberg.

E. Zodiacus, Ehr.—Not unfrequent in Ascidians.

ACHNANTHES, Bory.

A. longipes, Ag.—Very abundant in salt water. Victoria Dock Timber Pond, very copious and pure. Marsh Chapel. Humber Banks. Grimsby Timber Ponds. Very abundant on ships' bottoms after a long voyage.

A. brevipes, Ag.—Very abundant in salt water. Victoria Dock Timber Pond. Cleethorps. Humber Banks. Tetney. Ditches near Stoneferry. Abundant on ships' bottoms.

A. subsessilis, Kütz.—Rare. Pure and copious in pools on the Humber Banks, near Marfleet, attached to *Cladophora*.

A. exilis, Kütz.—Not unfrequent in fresh water. Springs, Newbald. Springs, Cottingham. Under a leaky tap. Wawne. Reservoir Waterworks.

ACHNANTHIDIUM, Kützing.

A. lanceolatum, Bréb.—Fresh water, not common. Ditch, Cottingham, near Mr. Harrison's Grounds. River Hull, at Wawne.

A. microcephalum, Kütz.—Rare in fresh water. On a wall under a leaky tap.

A. lineare—Sm.—Not unfrequent in fresh water. Cottingham Beck, attached to *Cladophora*. Benningholme. Pond at Skirlaugh.

RHABDONEMA, Kützing.

R. arcuatum, Kütz.—Frequent on *Cladophora* at Filey Bridge. Whitby. Flambro' Head. Ascidians. Dairycoats, Mr. Robt. Harrison.

R. Adriaticum, Kütz.—Rare. On *Coralline*, Whitby.

R. minutum, Kütz.—Rare. On *Coralline*, Whitby. Filey Bridge.

HYALOSIRA, Kützing.

H. delicatula, Kütz.—Abundant and nearly pure on a ship's bottom from San Felipe.

DIATOMA, Decandolle.

D. vulgare, Bory.—Frequent in fresh water. Reservoir Waterworks. River Hull, Wawne. River Derwent, at Malton. Harrogate. Ripley. Knaresbro'.
D. grande, Sm.—Rare. Wall under a leaky tap.
D. elongatum, Ag.—Common in fresh and brackish water. Pond, Skirlaugh. Reservoir Waterworks. Humber Banks, in pools. Ripley. Market Weighton Canal.
D. hyalinum, Kütz.—Very abundant and pure on a ship's bottom from Honduras. Also on a ship from San Felipe.

GRAMMATOPHORA, Ehrenberg.

G. marina, Kütz.—Abundant and pure on *Cladophora rupestris* Filey Bridge, and Flambro' Head. Whitby, on *Coralline*. Rare in Ascidians. Timber Pond, Victoria Dock, Dr. Munroe.
G. macilenta, Sm.—On *Coralline*, Whitby. Filey Bridge, sparingly.
G. serpentina, Kütz.—Rare. *Coralline*, Whitby. In a Dredging taken off Flambro' Head.
G. subtilissima, Bailey.—Abundant on *Cladophora* in a small pool on Filey Bridge.

TABELLARIA, Ehrenberg.

T. flocculosa, Kütz.—Not unfrequent in fresh water, though never abundant. Spring Head. Cottingham. Boggy ditch, Saltersgate. Spring Ditch. Risby Pond.

BIDDULPHIA, Gray.

B. aurita, Bréb.—Very frequent in Ascidians.
B. radiata, Roper. Not unfrequent in Ascidians.
B. Rhombus, Sm.—Frequent in Ascidian gatherings. Dredgings off Flambro' Head.
B. Baileyii, Sm.—Very frequent in Ascidian gatherings.
B. granulata, Roper.—Not unfrequent in Ascidian gatherings. Rare in a sand-gathering, Hornsea.
B. turgida, Sm.—Rare in Ascidian gatherings.

PODOSIRA, Ehrenberg.

P. hormoides, Kütz.—Ascidians. Dredgings, Flambro' Head.
P. maculata, Sm.—Abundant in Ascidians.

MELOSIRA, Agardh.

M. nummuloides, Kütz.—Abundant in salt and brackish water. Victoria Dock Timber Pond, pure. Grimsby. Humber Banks. Ditch near Stoneferry. Dairycoats.

M. Borrerii, Greg.—Abundant in salt and brackish water. Pure in pools, Humber Banks. Copious in Victoria Dock Timber Pond.

M. subflexilis, Kütz.—Local in brackish water. Pure in a ditch running from Stoneferry to Sutton.

M. varians, Ag.—Very abundant in almost every fresh-water stream. Pure and sporangial in a spring at Haltenprice. Spring Ditch. Cottingham. Wawne. Reservoir Waterworks. Harrogate. Ripley. Hornsea Deposit.

? *M. sps* with transverse lines. In Ascidians.

? *M. sps* with longitudinal lines. In Ascidians. Common also in Peruvian Guano.

ORTHOSIRA, Thwaites.

O. arenaria, Sm.—Pure in a spring, Newbald. Hornsea Deposit. Tank in a tropical Fernery and Orchid House.

O. marina, Sm.—Abundant in every Ascidian gathering. Sands at Hornsea.

O. spinosa, Sm.—Sparingly in the Hornsea Peat Deposit.

O. punctata, Sm.—Abundant in the Peat Deposit, Hornsea. Sparingly in an Ascidian gathering, probably accidental. In a brackish ditch leading from Stoneferry to Sutton, sparingly.

MASTOGLOIA, Thwaites.

M. Danseii, Thw.—Rare. Outlet, Hornsea Meer.

M. Smithii, Thw.—Rare in brackish water. Stallingbro'. Humber Bank. Ditch, near Stoneferry rare.

M. lanceolata, Thw.—Rare. Timber Pond, Victoria Dock, Mr. Robt. Harrison.

M. apiculata, Sm.—Rare with the above, Mr. Robt. Harrison.

BERKELEYA, Greville.

B. "fragilis, Grev.—Rare. Dairycoats," Mr. Robt. Harrison.

ENCYONEMA, Kützing.

E. prostratum, Ralfs.—Not unfrequent in fresh water. River Hull, Wawne. Reservoir Waterworks, copious. Harrogate. Newland, Toft Lane, near Cemetery, Dr. Munroe.

E. cæspitosum, Kütz.—Frequent in fresh water. River Hull, Wawne. Reservoir Waterworks. Stream "Birk Cragg," Harrogate. Newland, Toft Lane, Dr. Munroe.

COLLETONEMA, Brébisson.

C. eximium, Thw.—Not unfrequent, though always much mixed. River Hull, near Stoneferry, frequent. Wawne. Outlet to Hornsea Meer.

C. vulgare, Thw.—Rare. Spring at Cottingham.

C. neglectum, Thw.—Rare in fresh water. Wall under a leaky tap. River Hull, Wawne. Reservoir Waterworks.

SCHIZONEMA, Agardh.

S. crucigerum, Sm.—Very frequent in salt and brackish water. Copious and nearly pure in the Victoria Dock Timber Pond. Outlet Hornsea Meer. Tetney. Humber Banks. Grimsby Timber Pond.

S. Smithii, Ag.—Abundant, growing on the submerged Peat Beds at Hornsea.

S. divergens, Sm.—Salt-water ditch, Marsh Chapel.

S. Dillwynii, Ag.—Not unfrequent in brackish water. Humber Banks. Copious, Victoria Dock Timber Pond.

S. laciniatum, Harv.—Abundant on Rocks, Flambro' Head.

S. helmintosum, Chauv.—Timber Pond, Victoria, Dock, Mr. Robt. Harrison.

HOMŒOCLADIA, Agardh.

H. sigmoidea, Sm.—Abundant on the Piers of the Victoria Dock. New Holland Jetty. Breakwater near Hessle.

GLOIONEMA, Ehrenberg.

G. sigmoidea? Ehr.—Abundant in the Magnesian Well, Harrogate. Also abundant on some mooring posts near Dairycoats.

ASTERIONELLA, Hassell.

A. formosa, Hass.—Not unfrequent in the wooden Outlet to the Pond at Ripley Castle.

A. Ralfsii, Sm.—Very frequent in Ascidians.

A. Bleakeleyii, Sm.?—Rare in an Ascidian gathering.

CRESSWELLIA, Arnott.

A. Turris, Arnott.—Frequent in Ascidians.

RHIZOSOLENIA, Ehrenberg.

R. styliformis, Brightwell. — Very abundant in Ascidian gatherings.
R. robusta, Nor. M. S.—Not unfrequent in Ascidians.
R. imbricata, Brightw.—Frequent in Ascidians.
R. alata, Brightw.—Very frequent in Ascidians.
R. setigera, Brightw.—Not uncommon with the above.
R. Calcar-avis, Schultz.—Rare. In an Ascidian.

SYNDENDRIUM, Ehrenberg.

R. diadema, Ehr.—Rare. In Ascidians.

DICLADIA, Ehrenberg.

D. capreolis, Ehr.—Rare. In Ascidians.

CHŒTOCERAS, Ehrenberg.

C. Wighamii, Brightw.—Frequent in Ascidians.
C. bacillaria, Bailey.—Not unfrequent in Ascidians.
C. boreale, Bailey.—Frequent in Ascidians.
C. Peruvianum, Brightw.—Rare. In Ascidians.

BACTERIASTRUM, Ehrenberg.

B. furcatum.—Frequent in Ascidians.

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ORIGINAL COMMUNICATIONS.

On the Structure *and* Mode *of* Formation *of* Starch Granules, *according to the* Principle *of* "Molecular Coalescence." By George Rainey, M.R.C.S., Lecturer on Microscopical Anatomy at St. Thomas's Hospital.

Starch, from its physiological importance, remarkable structural peculiarities, and general diffusion through the vegetable kingdom, has been a favourite subject of investigation with physiologists and microscopists. However, notwithstanding the attention which has been devoted to its structure and development, it is acknowledged by the greatest physiologists to be known but little of. (See Mr. Busk's paper on "Starch Granules," in the number of the 'Quarterly Journal of Microscopical Science' for April, 1853.) There are, doubtless, intrinsic difficulties attending the investigation of this substance, but these have been very much augmented by the principle on which the examination has been conducted, namely, the cellular hypothesis. If this hypothesis had been in itself correct, and admissible as a basis of explanation of the facts connected with the structure and mode of formation of the starch granule, it ought, considering the amount of talent and ingenuity which have been employed in its application to these inquiries, to have thrown more light upon these much disputed, and as yet entirely unsettled questions.

After this apology for thus differing from the high and almost universally credited authorities of the present day, I shall proceed to explain on a new principle—one strictly mechanical in its immediate operation—"the principle of molecular coalescence,"—those points connected with the structure and development of starch granules, by which physiologists and botanists have been so long puzzled. In this paper the same train of reasoning will be employed, and the same experimental data adduced, as in my last paper, that on the "Structure and Mode of Formation of the Dental Tissues," as also in that on "Shell Structures;" and hence, though treating of a very different class of organized structures, this is still but an extension of my former researches.

It may at first appear startling that substances so dissimilar as carbonate of lime, as found in shells, or a mixture of carbonate and phosphate of lime, as it occurs in bone or dentine, should have anything in common either in their structure or in the manner in which they are formed; but I may remark that none of these structures is so simple, and so exclusively mineral or organic as is generally supposed. The carbonates and phosphates of a rounded form are all compounds of a viscid substance and earthy matter; and starch granules have diffused through their structure a small quantity of earthy matter. I have always found that starch burnt to ash on platinum leaves a residue of lime; but desirous to have more precise knowledge upon this point, I availed myself of the advantage of the assistance of Dr. Moldenhauer, the chemical assistant at St. Thomas's Hospital, in making for me a quantitative analysis of some potato-starch prepared for the purpose. The result of which is, in 100 grains of dry potato-starch—

Dry starch . . .	80·80
Water . . .	18·94
Ashes . . .	·26
	100·00

These ashes we found to contain silica and phosphate of lime; the proportions I did not think it necessary to have determined. However, the globular form of the carbonate of lime, occurring in the deep layer of the shells of Crustaceans, is as high in the physiological scale as the granules of starch.

In treating this subject I shall first consider the different forms in which the particles of starch occur, and their resemblance to corresponding forms of certain solid bodies, undoubtedly produced by the coalescence of their particles; and then I shall show that the chemical and mechanical conditions necessary to produce such forms of starch exist in the vegetable organization. The various forms of starch must be examined both when the starch is in the starch-cells and after it has been removed from them. Sections of growing vegetables in which starch is formed in large quantities, as in the very young tubers of potatoes, will serve for this purpose. In such sections, in this and the majority of plants, the starch-cells in the vicinity of the ramifications of the vessels will be seen to contain very small spherules of starch, many of them too minute to be accurately measured; yet, notwithstanding their minuteness, their figure is well defined, and they are made black or blue by iodine, proving

that they are as much starch as the larger globules, and differing from them in nothing but size. These spherules may either be free in their starch-cells, or conglomerated and joined together in pairs or threes, producing dumb-bell or somewhat triangular forms. Sometimes they are found with shreds of membrane, and at others are invested more or less by an utricle. In the starch-cells more remote, the granules are larger and fewer, so that their increase in size is attended with a diminution in number, showing most clearly that the largest are the product of the union of those of an inferior size. Indeed, the number of granules of a small size is such in some of the starch cells that it would be impossible that they all could become developed into large granules without the spaces containing them undergoing a most inordinate increase in size, which is not the fact; the spaces in which the middle-sized granules are lodged being about the same size as those containing the largest granules. But the chief evidence in support of this conclusion must be obtained from the microscopic examination of all the various forms of starch, beginning with that which is merely granular, and going up to that which is most perfect. Such an examination will show that there are exactly the same class of appearances to be found in starch, indicative of coalescence of its particles, as are presented by the several forms of carbonate of lime, whether prepared artificially or occurring in organized tissues.

Plate I contains representations of different forms of starch; fig. 1 is the ordinary form of the larger granules. This was taken from the immature fruit of the potato. Nothing that I have examined shows the laminated character of starch granules so well as these potato apples, as they are called. Figs. 2 and 3, drawn from specimens of common potato starch, are similar to those pointed out by Mr. E. J. Quekett as the result of cell multiplication by division, a view still, I believe, generally entertained by botanists. This hypothesis is considered by physiologists to apply only to even numbers, but fig. 4, and also fig. 5, which latter is copied from Crüger's plate in the 'Journ. of Micros. Science,' for April, 1854, show three granules similarly united, all as nearly as possible of the same size. Now the question is whether this hypothesis extends also to uneven numbers, or whether these specimens are merely three granules joined together, and in an early stage of coalescence. Examples of this form are not uncommon. In the specimen of starch from which these were taken there was no difficulty in finding them, being almost as common as the pairs. This starch

was prepared from potatoes which had been kept nearly a year. I have dwelt upon this form, as appearing to me rather singular that it should not have been observed by more botanists; perhaps if it had been sought for as diligently as the granules in pairs its existence would have been more generally noticed. This observation may serve as a hint in the examination of other structures in which the division of cells into two is said to take place as in cartilage. I am perfectly aware that triplets with granules of nearly equal size will, as a matter of course, be less frequent than similar pairs. Those represented in figs. 2 and 3 are a modification of the dumb-bell shape, which is seen much better in the smaller granules which unite before they lose their spherical form. These may be well seen in thin transverse sections of the very young houseleek, *Sempervivum tectorum*.

Figs. 6 and 7 are representations of a description of starch granule, called by physiologists "compound granules." These have been variously explained by different authors, but in all cases which have come under my notice the explanation of the central part of such granules has been made dependent upon some assumption which has been irreconcilable with the principle of explanation applied to the peripheral part.*

Fig. 6 is taken from Crüger's plate, as copied in the 'Microscopical Journal.' This copy, I may observe, is not introduced here, from my being unable to obtain similar specimens myself. They are frequent enough in the kind of starch called "tous les mois," but the facts very well shown by these drawings will have more weight as coming from different and independent observers. These granules consist of two or more simple granules, each having its own lamellæ, and the whole surrounded by common lamellæ.

Fig. 8 is an accurate representation of two globules of carbonate of lime from the calcifying shell of the oyster. There is so striking a resemblance between the structure of these and those marked fig. 6, that no one would question their laminated structure and their union as being otherwise than the result of a similar cause, and very likely to be produced in both cases, either by the layers of increment deposited on the inner surface of a cell-wall, or by the layers deposited around a centre or nucleus. Such was the conclusion arrived at respecting these bodies by physiologists before it was shown by me, in 1857, that exactly such forms as that represented in fig. 8 could be produced artificially, and that there were sufficient grounds for be-

* See these treated of in the April number of 1854 of the 'Quarterly Journal of Microscopical Science,' by Dr. Allman and H. Crüger.

lieving that the chemical and mechanical conditions which were employed in the experimental process for obtaining them existed in the animal organization, and therefore that both kinds of carbonate globules were of the same structure and produced under the influence of the same agencies.

Fig. 9 is a representation of some of the largest kind of artificial globules joined together, and in progress of coalescence to form a single one, just as those represented by fig. 8 are; and, doubtless, the globules of starch in figs. 6 and 7 are in a like condition of coalescence.

I will now proceed to the second part of this paper, that is, to show that chemical and mechanical conditions similar to those in the experimental process for obtaining carbonate of lime globules, and which are necessary, on the same principle, to produce these several forms of starch, exist in the vegetable organization. This I look upon as the most novel and important part of this communication.

Now, as it is a fact generally admitted, that vegetable membrane is impermeable by solids, however minute may be their particles, it can only be in the interior of the starch-cells that starch can receive its solid form. Hence, there must exist in solution in these cavities some fluid capable of furnishing starch, or from which starch can be precipitated on the access of a second fluid containing some one or other of the constituents of starch in solution. Now, with respect to the first solution there will not be much difficulty, as dextrine—"a soluble substance found in almost all parts of plants"—or some solution analogous to it, will fulfil this—the first—condition. And as respects the second, the difficulty is still less, as there is no known solution but that of gum, which is diffused generally through plants. Hence, if starch be produced upon the principle of precipitation, from a fluid within the starch-cell, as the globular carbonate, and the mixture of globular carbonate with phosphate of lime are in the hard tissues of animals, there is no other solution but that of gum, which, from its general diffusion in the tissue of these cells, can precipitate it. Now, to show that these substances, under the circumstances they exist in vegetables, will perfectly fulfil all the conditions necessary for the formation of starch in the cells of plants, I will give some out of the many experiments which I have made for that purpose.

I will first show that gum possesses some remarkable properties which, I believe, are entirely unknown both to chemists and physiologists. One of these properties is its action as a general precipitant of substances contained in solution in the juices of plants, and the other is its action on dextrine,

from which it precipitates a modified form of starch, and, on an alkaline solution of starch, from which it precipitates pure starch. To show the first property—that of a general precipitant—it is necessary to obtain the expressed juice of fresh vegetables, previously bruised or rasped, and filtered through blotting-paper once or twice, so that it may be perfectly clear. Some of this juice is then to be filtered into a test-tube, into which a small quantity of filtered solution of gum arabic has been introduced, when, after these fluids have remained for a few minutes, the stratum of juice in contact with the solution of gum will lose its transparency, become turbid, and soon deposit, in greater or less quantity, the vegetable matter which it had held in solution. I have performed this experiment upon the juice of several plants, and always with the same result. The juice of the bruised stems of the potato, as also that of the rasped bulbs, will serve very well for this experiment, and especially the latter, as it can at all times be procured. I may observe, that the filtered juice of some vegetables will, after standing a short time, without the addition of any gum, become turbid and deposit of itself. But this deposit I have not mistaken for that produced by the gum, the latter beginning to be apparent within a minute or two after the contact of the gum with the expressed juice, whilst the former requires several hours, or an indefinite time, for its production. I may also notice, that this property of gum is not, so far as I can discover, attributable to any earthy or metallic salt which it may contain, or to the acid which is generated by it, after being kept for some time in solution, but it appears to be essentially a property of vegetable gum, that is, of a substance which forms with water an adhesive solution, from which it is precipitated by silicate of potash, and thrown down by alcohol in the form of opaque white flakes. As, in order to be assured upon this point, I employed in my experiments gum from which the salts of lime had been separated by oxalate of ammonia, also gum which had been precipitated from its solution in water by alcohol, and after that dried and redissolved in water, also a solution of gum made slightly alkaline, all with essentially the same result as that obtained by the unpurified gum. I will now give some experiments showing the effect of gum upon dextrine, and upon starch dissolved in a solution of potash. It is well known that dextrine is formed by heating starch, and also by the action of sulphuric acid upon starch; I therefore obtained a substance known in commerce by the title of soluble gum. It is made by applying heat to starch in a suitable apparatus.

This, when put into cold water, affords a solution, which is turned brown by the action of iodine. This is a solution of dextrine. I also obtained a similar solution by mixing potato starch with sulphuric, muriatic, and nitric acids. But I generally employed that made with muriatic acid, in consequence of its not precipitating the lime from the gum, which sulphuric acid did, as a sulphate of lime, and hence did not require purified gum to be employed in the experiments with it. I employed, likewise, a dextrine made by dissolving soluble gum in water with citric acid. This I did, in consequence of the muriatic and sulphuric acids having a particular action upon gum—that of converting it into a transparent insoluble substance, which the citric acid does not.

To show the effect of a solution of gum in precipitating starch from dextrine, the same mode of experimenting as that just described in reference to its action upon the juice of plants may be employed. One way which I have found convenient to demonstrate the action of gum upon a solution of dextrine, is to put on a microscope slide a few drops of very thick solution of gum, and on the top of that a drop or two of solution of soluble gum, or of starch, acted upon by an acid, and then to examine these with the microscope whilst the action is going on, and without placing upon them any cover of glass, when it will be seen that the solution of gum causes the solidification of the dextrine starch in minute particles, having a finely granular appearance. The two solutions seem also to exert a repellant action on one another, and the starch runs into globular forms, just as oil would do if placed on water. To show this fact, and the form given to the starch, these solutions should afterwards be allowed to dry on the slide, and a drop of solution of iodide of potassium, containing also some tincture of iodine, added; and then over them a cover of thin glass may be placed. The form which the starch had taken will be seen by the colour imparted to it by the iodine. On washing these with water the circular patches of starch will be broken up, but the starch itself will remain solidified in granules of various shapes and sizes. With a view to determine how far these effects might be attributable to the medium in which the starch had been dissolved, I dissolved some potato starch in a solution of caustic potash, and, after having filtered the solution until it was entirely without any solid matter, placed a drop of it upon a solution of gum, and proceeded precisely in the same manner as described in the last experiment. I found that exactly the same effect was produced, that is, the solidifica-

tion of the starch. After these had been allowed to dry on the glass as before directed, the starch thus precipitated was transferred from the slide to a watch-glass filled with water, and allowed to remain until the gum was all dissolved, and then it was washed several times. In this case it does not alter its form, which is that of a granular areolated film of solid matter, which, from the action of iodine upon every particle of it, is shown with certainty to be starch. Potash does not convert starch into dextrine like the mineral acid, but seems to dissolve it nearly, or entirely, unchanged.* The most easy way of demonstrating the effect of gum upon dextrine is to mix some solution of dextrine, made from soluble gum, dissolved in a solution of citric acid (this acid is used only to get a stronger solution) with the solution of iodine above specified, when a purple brown fluid will result, then to put a few drops of it on a glass slide close to a like quantity of clear solution of gum of considerable density. These must be made to mix under the microscope, and the effect carefully observed. The first thing which will be observable will be the precipitation of the starch in very minute granules, at first colourless, but afterwards, and almost instantly, becoming blue or dark pink. And, if the quantity of starch be considerable, the blue colour will remain for several days without changing, but, if only small, it will turn gradually pink, and so will remain unless fresh iodine be added, when it will become of a dark color. A part of the blue tint, at first produced on adding the solution of gum, is the effect of the dilution of the solution of the iodized dextrine, and can be produced by water, but in this case there is no precipitation, and, as the solution gets inspissated by the evaporation of the water, the original purple-brown of the dextrine becomes restored. For this experiment starch treated with muriatic acid, or, sulphuric will not answer in consequence of a part of the starch only being converted into dextrine, and the other being held in solution, so that when the iodine is added the latter is precipitated. When the solution contains only dextrine nothing is thrown down by the iodine.

The result of these experiments, taken altogether, shows that so completely is gum a precipitant of starch that it matters not whether it is in solution in an acid, or an alkaline menstruum, the effect is the same, although in these two cases the characters of the starch thus deposited are, as before

* When potash is employed, the lime must be separated from the gum by oxalate of ammonia, otherwise the granular film of starch will be studded with particles of the globular carbonate of lime.

noticed, more decided in the latter than in the former. Now, gum is not the produce of any particular vegetable cells, nor is it confined to any class of plants, but it appears to be a secretion generally diffused through the tissues of all plants. Hence, combining these two circumstances, the general existence of gum in vegetables, and its property as a precipitant, I hold that one of the conditions necessary for explaining the presence of solid substances in the cells of plants by a process of precipitation is demonstrated. I need scarcely add, that the solution of gum would gain access to the fluid within the starch-cells—all by a process of endosmose. And, as to dextrine, it is generally admitted to be matter assimilated in the cells of plants for the purposes of nutrition, and therefore it is only necessary to suppose that in certain cells some such a solution of starch, as that made artificially by mixing starch and alkali together, is elaborated; (and alkali, in some form or other, is well known to be essential to the growth of plants,) and then we shall have the other condition requisite for the same process. And with such conditions there is no difficulty in seeing how a kind of modified starch, as cellulose, or the imperfect forms of chlorophylle, would be deposited in the former cells, those containing the dextrine, and pure starch in the latter. I am perfectly aware that this explanation will be considered by the vitalists as being too physical, but still it is no more so than the formation of bodies of a similar form in the shells of Molluscs and Crustaceans. The molecules of starch being thus formed and deposited, will, after repeated coalescences, produce all the forms described and represented in the accompanying plate.

The form of some of the larger starch granules may appear at first sight to have no representatives among the calcareous deposits, either natural or artificial, but this is perfectly explicable upon physical principles, and, when duly considered, is in favour of the principle of molecular coalescence. A similar difference of shape, though not to so great an extent, obtains also with the natural and artificial globules. In all the three cases the most nearly spherical forms of single globules are among the smallest, the mutual attraction of their molecules upon which rotundity depends, being less interfered with in these by the simultaneous attraction of surrounding objects than in the larger globules, as would be the case with globules of quicksilver of different sizes, placed upon a piece of glass or a sheet of paper, the smallest would be the roundest. As the particles get larger their molecules become more effectively attracted by adjacent masses of

matter, and thus the centre of attraction common to the molecules of the globule in progress of formation, and the surrounding particles of matter, towards which centre all these molecules are effectively or ineffectively attracted, cannot be the geometrical centre of the globule in question; and hence a globule formed under such circumstances cannot be accurately spherical. These conditions must always exist as well during the formation of the calcareous globules as during that of the granules of starch, but they will operate more as disturbing causes in the latter than in the former, just in proportion as the molecules of starch are less dense than those of carbonate of lime. Hence these peculiarities in the form of the large granules of starch are no more than might have been expected. The small granules of starch are, to all appearance, as spherical as those of the carbonate of lime of the same size. For an explanation of the manner in which the granules of starch acquire their laminated form, and the mode in which the hilum, the part corresponding to the central spot in the artificial calculi, is formed, I must refer to my work on the 'Mode of Formation of Shells of Animals, of Bone, and of several other Structures, by a process of Molecular Coalescence.'

I should have been glad to have introduced into this paper a condensed account of this process, as given in the volume referred to, had not the necessarily elementary character in which the process is there explained rendered the necessary abridgement of that explanation impracticable.

With respect to the chemical action of gum, and the chemical nature of the deposits thrown from the vegetable juices, I have not yet been able to make any strict investigation. I feel certain, from what I have noticed, that the subject is one of importance, and it is not impossible that it may pave the way to the discovery of similar facts connected with the action of the fluids in animal tissues. In reference to the action of gum in precipitating starch, it is not improbable that, as starch contains a minute portion of phosphate of lime, which can only have been derived from the gum, in which this salt is well known to exist, gum may furnish other constituents of starch, and also some portion of all the other substances which it has the power of precipitating, and that thus it may act both as a medium by which the various substances existing in plants are carried to the cells in which they are elaborated, and as a means of solidifying them after they have undergone the necessary elaboration.

Descriptions *of* Diatomaceæ, *chiefly of those found in* "Elide" (*Lower California*) Guano. By Christopher Johnston, M.D., of Baltimore, U.S.

I am fully aware of the fallacies which beset the diatomist who establishes new species from the inspection of rare, isolated, and prepared valves; but I am of opinion that science is made the gainer by his efforts, provided he is careful not to substitute *names* for *things*, and fancy for the sense. If the observer states the circumstances under which he obtained his facts, it is certainly pardonable in him to group these together in such a manner as to guide others in extending the limits of knowledge, whether by verifying his specification, or by modifying it, when accumulated observations justify the emendation.

Species have, doubtless, been disadvantageously multiplied; but it must be allowed that this error has not unfrequently been innocently committed, either when descriptions in systematic works failed to identify supposed novelties, or the published figures evidenced no correspondence with them. Accurate figures are, unquestionably, of great service in many respects, for they are duplicates, so to speak, of the original specimen; and "if they fail in some cases to establish species, they will, at least, assist to indicate the range of variation, a point in itself of no small importance." Indeed, it may be said that exactness in description and delineation must largely contribute towards lessening the useless load of nomenclature with which science is charged.

The source whence the specimens here noticed were derived was Californian guano, from the Island of Elide, on the coast of Lower California (lat. 29° N.); Patagonian guano; and the stomachal contents of oysters from Pongateague Creek, on the Chesapeake side of the eastern shore of Virginia.

Spatangidum, *De Brébisson.*

It would seem to be a superfluous task to recur to this "noble diatom" with a knowledge of Greville's delightful paper on Diatomaceæ which appeared in the April number of this Journal. But I have thought it not unprofitable to add to that author's description of a single valve my own observation of the appearance presented when both are attached, for the character thus afforded is remarkable.

In isolating specimens preparatory to mounting in the dry

way and in balsam, it was very easy to perceive that the front view (or edge) of Spatangidum was not straight, but sinuous or zigzag; and it occurred to me that the rays of both could not coincide when the valves were together. I was fortunate in finding three individuals in pairs such as I had wished. The colour is darker, of course, than that of a single disc; instead of seven rays there appear fourteen, alternating in depth of hue; and the reticulation extends uninterruptedly over the whole extra-hyaline area, but is fainter in the course of a ray as it overlies the inferior inter-radial network. Diameter $\frac{1}{258}''$.

From "Elide."

In the dry preparation all the rays are brighter than the interspaces, and the reticulation over and under the former more distinct.

ASTEROMPHALUS, *Ehr.*

Asteromphalus centraster, n. sp.—Orbicular, of a pale buff beyond the hyaline area, which is very slightly excentrical. Rays straight, turgid in the area, diminishing gradually, and terminating in a flattened nodule situated just within the marginal line; nucleal ray longer and narrower than the others, which are inserted on its extremity, and very near it on the sides. The hyaline area has a scalloped border, convex inwardly, each inter-radial space being bisected by a delicate secondary ray terminating outwardly in a nodule, and about three sevenths of the radius in length. Margin very finely dotted, showing best in lines at right angle with the secondary ray. The crescentic edge of the hyaline area and the rays beyond it bordered with minute granules.

The number of rays of this charming species is eleven, and they are equidistant. I regret to say that I have found but a single disc. Diameter $\frac{1}{340}''$. (Pl. I, fig. 10.)

In Elide guano.

CAMPYLODISCUS, *Ehr.*

C. productus, n. sp.—Valve inconsiderably bent; elongated and constricted at the middle. Canaliculi about one fourth the transverse diameter, each marked by a small node midway as it expands outwardly; margin broken by depressions not corresponding with the canaliculi, and bearing a double row of small dots. Within the canaliculi, at either extremity, an elongated crescent of fine granules fading towards the centre. Diameters $\frac{1}{171}'' \times \frac{1}{380}''$.

In Elide guano.

Of this and the following elegant species I have met with but a single example, although I have searched diligently in numerous preparations.

In the specimen above noticed the canaliculi numbered thirty-seven.

C. marginatus, n. sp.—Disc ovoid, bent; rays numerous, marginal, short, separated externally by a nodule, and internally also by a larger one on either side of the transverse axis; the inclosed field divided by a longitudinal fusiform of smooth space; the remainder marked by rows faint dots, straight in the direction of the transverse axis, but becoming concentric with the extremities of the long axis. Diameter $\frac{1}{200}''$. (Fig. 11.)

In Elide guano.

Cocconeis, *Ehr.*

C. regina, n .sp., C. J.—Frustule ovoid, bluish green; striæ numerous, 20 in 0·001″, concentric around the extremities; on either side of the nucleal line the extremities of the striæ distinctly granular; in their course outwards faintly moniliform, but more conspicuously beaded peripherally, forming a sort of margin of the width of three or four granules. Diameter $\frac{1}{170}''$. (Fig. 12.)

In Elide guano.

This exquisite species is not abundant in the residue furnished by the guano. There is but little variation in size, the diameter given above being that of the largest frustule I have encountered.

Stauroneis, *Ehr.*

S. angulata, n. sp.—General form of the valve elongated oval, extremities somewhat acuminate; the marginal line bending on either side as it advances at about one third the distance from the transverse axis, at which it makes a wide but distinct angle. A narrow band of finely granular striæ, disposed transversely, surrounds a clear field, and, becoming suddenly narrower at the extremities, is continuous on either side of the carina with a delicate longitudinal band of very minute granules, terminating in a point outwardly at the stauros, which is short. Edge beaded. Diameters $\frac{1}{170}''' \times \frac{1}{112}'''$.

In Elide guano.

Heliopelta, *Ehr.*

H. Phaeton, n. sp.—Frustule quasi-orbicular, many sided, the number of sides being twice that of the rays.

Centre smooth; the surface of the disc presents alternating wedge-shaped elevations (rays) and depressions, which originate at the centre, the former pointedly; on each ray there proceeds from a marginal nodule a delicate acicular rib, which terminates apically near the umbilicus, and in the middle of each depression a delicate line. Very faint indications of reticulation just within the margin. The whole surface, exclusive of the centre, covered with extremely minute quincuncially arranged puncta; and at the margin an encompassing row of fine granules. Colour very pale straw. Diameter $\frac{1}{174}$″ to $\frac{1}{130}$″.

In Elide guano.

In my specimens the rays are twelve in number.

Arachnoidiscus, *Ehr.*

A valve of Arachnoidiscus was found, which is interesting as a variety of that genus, if it have not distinctive specific characters. The centre is clear, immediately surrounded by irregularly disposed granules, larger than those on the general surface. In the same guano I found a number of frustules, not distinguishable from *A. japonicus*, having regular central rays, which is not the case with the one I have delineated. Diameter $\frac{1}{282}$″.

In Elide guano.

Achnanthes, *Bory.*

A. angustata, Greville (?)—*Front view.*—Much bent. Transversely banded, bands resolvable into dots, 26 in 0·001″. Half of the hoop transversely striated. A row of granules along the base of each frustule, those of the upper one being very fine. An apparent aperture (not an opening) at the inferior extremities of the under valve. Length $\frac{1}{127}$″.

Side view.—Both valves elongated, slightly swollen in the middle, and with rounded extremities. Transversely banded, the striæ being rows of dots, interrupted by a line near to and parallel with the margin. Externally the striæ are alternately swollen, giving the appearance shown in the figure. *Upper valve* traversed by a central longitudinal row of puncta, around which, at the extremities, the striæ are radiate. *Lower valve* similarly divided, but the extremities, instead of being entire, *appear* to be largely perforated; in the clear space a crescentic line. Width $\frac{1}{782}$″. (Fig. 13 *a*, *b*, *f*.)

In Elide guano.

This species presents a striking contrast with the following,

which is also very beautiful; but while the form and the markings differ, the general characters of upper and lower valves are preserved.

A. costatus, n. sp.—*Front view.*—Curved, the superior angles recurved upwards. Both valves transversely costate, each row bisected. Length $\frac{1}{188}$".

Side view.—Both valves with rounded extremities; the edges nearly linear. On either side two rows of coarse transverse striæ, bounded by a line within the border. The striæ on opposite sides alternate, and their points form a zigzag along the median line. The whole surface covered as with a veil of extremely minute puncta.

The extremities of the *upper valve* exhibit a radiate disposition of the bands; whereas an apparent oval deficiency exists in the lower frustule, but without the inner crescentic line, as in *A. angustata*. Width $\frac{1}{1088}$". (Fig. 14 *a*, *b*, *f*.)

In Patagonian guano.

Pleurosigma, *Smith.*

P. makron, n. sp.—Has the general characters of *P. Balticum*, but differs from that diatom in its extraordinary dimensions, its conspicuous convexity longitudinally on either side of the keel, the coarseness of its markings, and the attendant colour, dusky olive. Length $\frac{1}{47}$"; width $\frac{1}{511}$"; dots 30 in 0·001" longitudinally, and 33 in 0·001" transversely.

Pongateague, Virginia.

P. ——.—Probably a variety only of *P. Balticum*. Length $\frac{1}{44}$"; width $\frac{1}{838}$"; dots 36 in 0·001". Frustules slightly swollen near the extremities; and is of a deeper reddish-brown than its congener.

Pongateague, Virginia.

I have had no opportunity of examining the diatoms of the lower part of the Chesapeake Bay, except as derived from oysters cultivated there. They occur, however, in rich variety and profusion, embracing many beautiful species of Nitzschia, Navicula, Pleurosigma, Coscinodiscus, &c. But, from an inspection of a considerable number of prepared valves (always separate and viewed laterally), I think that *P. makron* may be safely admitted as a new species; for although there is some little variation as to size, the appearance of the valves, their peculiar hue, and the distance separating the dots, remain constant. The characters are, consequently, *tranchés*.

With regard to *P.* ——, there are, to distinguish it from *P. Balticum*—1st, the length $\frac{1}{44}$", while the latter is but $\frac{1}{77}$" by my own measurement; 2d, the turgidity of the

frustule towards either end; and, 3d, the disproportion between the two diameters—19 to 1; features sufficient to establish a variety, but not, as was remarked by A. M. Edwards, Esq., of such importance as to justify the erection of a species.

It may be stated that Pongateague Creek, the habitat of these large diatoms, is a shallow inlet of the Chesapeake visited by the tide.

BALTIMORE, MARYLAND;
May 20th, 1859.

We print the foregoing communication as containing descriptions of Diatomaceæ from a locality which has hitherto been little noticed, but as the author appears to have overlooked the works of some writers in this country, we append the following notes on some of the species by Professor Walker-Arnott and Mr. F. C. S. Roper.

NOTE BY MR. ROPER.

The species described by Mr. Johnston in the foregoing paper appear, as far as I can make out from his descriptions and the very well-drawn figures that accompany them, to be mostly known to observers in this country. The fact that he notices with respect to *Spatangidum Ralfsianum*, Grev., of the rays in the two valves being disposed alternately, so that the ray on the superior valve is opposite to the areolated portion of the lower in the perfect frustule, has already been noticed by Mr. Shadbolt,* in Asterolampra, a kindred genus, and, I believe, is well known to be the constant rule in both Spatangidum and Asteromphalus, should these genera, on more careful consideration, prove distinct. They have been adopted, however, by such acute observers as Dr. Greville and M. De Brébisson, and though they appear to differ as to the limits of each, my own impression is that both are formed on one common plan, and should both be united under Ehrenberg's original genus of Asteromphalus, the differences only being sufficient to afford specific characters.

Asteromphalus centraster, Johnston (fig. 10).—It is impossible to form an opinion on this species without seeing the specimens. The structure, both from the description and figure, appears to differ materially both from the genus

* 'Micr. Jour.,' vol. ii, p. 17.

Asteromphalus, as defined by Dr. Greville,* and from the genera Asteromphalus and Asterolampra, as described by Ehrenberg.† The rays differ from any hitherto recorded species of Asteromphalus, whilst the areolated segments, being all equal and similar, and connected with the centre by what Mr. Johnston calls the secondary ray, would seem to show greater affinity to Asterolampra. It will require a careful examination of many more than the single specimen recorded by the author before its position can be safely decided on.

Campylodiscus productus, Johnston.—A careful comparison of the description and figure of this species with those given of *Surirella lata* by Professor Smith,‡ and an examination of the variations that occur in any good gathering of that species, will, I think, leave little doubt that they are identically the same. The number of canaliculi is stated by Professor Smith to be 3 or 4 in ·001, and in his figure there are 33 in all; in Mr. Johnston's species there are 37. The length given by Professor Smith is ·0041 to ·0062, whilst Mr. Johnston states his to be ·0058. The only difference appears to be in the length of the canaliculi and in the "crescent" of granules in the centre; but as the markings and canaliculi are subject to considerable variation in most species of Surirella, this would be no good ground for specific distinction.

Campylodiscus marginatus, Johnston (fig. 11).—The generic position of this species is doubtless correct, but whether it can be safely considered a new species from the examination of a single valve may be questioned, as the only characters that would distinguish it from the *C. limbatus* of M. De Brébisson§ are the greater separation of the canaliculi, and the more strongly marked central area. In outline and general character they are closely allied. Professor Gregory proposed the same name for a species he detected in the dredgings from the Clyde, but on consideration adopted the name already published by M. De Brébisson, and has given figures and description.‖ The markings of the central area are a point of little specific value, as has already been pointed out in regard to *Camp. Hodgsonii*.¶.

Cocconeis regina, Johnston (fig. 12).—This appears to be cor-

* 'Micr. Jour.,' vol. xxvii, p. 100.
† 'Berlin Proceedings,' 1844, pp. 73, 198.
‡ 'Synopsis,' vol. i, t. ix, f. 61.
§ 'Diatomées de Cherbourg,' p. 12, t. i, f. 1.
‖ Gregory, 'Marine Diatoms of the Clyde,' t. iii, f. 5.
¶ 'Micr. Jour.,' vol. vi, Trans., p. 86.

rectly referred to this genus, and is probably a new and certainly a fine species. The absence of any trace of central nodule would seem to exclude it from Professor Smith's definition of the genus, but it is not unfrequently absent in the lower valves of many species.

Stauroneis angulata, Johnston.—The correct position of this species appears to have been misunderstood by the author, as there is no true stauros, and there can be but little doubt that it is either the *Navicula Hennedyii* of the 'Synopsis'* and Professor Gregory's Glenshira sand,† or a variety of that form. It agrees closely in size with the dimensions given by Professor Smith, and the whole structure of the valve is identically the same.

Heliopelta Phaeton, Johnston.—The true generic position of this species has also been quite overlooked, as any reference to Ehrenberg's description and figures of Heliopelta would have shown. It ought evidently to be referred to one of the numerous forms of Actinoptychus or Actinocyclus, and is probably *Actinocyclus duodenarius* of Smith's 'Synopsis,' vol. ii, p. 86, or the *Actinoptychus duodenarius* of the 'Mikrog.,' t. xviii, f. 24. A description and figure of Heliopelta will be found in 'Silliman's Journal' for 1845, vol. xlviii, p. 338, tab. vi, fig. B.

The *Arachnoidiscus* —— ? is the *A. Ehrenbergii*. See Dr. Walker-Arnott, in 'Micr. Journ.,' vol. vi, p. 162.

Pleurosigma makron, though large, and probably from that cause with more strongly marked striæ, agree so closely, both in form and structure with *P. Balticum* of Professor Smith, that there can be no grounds for theirs epara- tion from that species.

Note on Figs. 13 and 14, by Dr. Walker-Arnott.

Both these forms clearly belong to the genus Gephyria, established by me in 'Micr. Journ.,' vol. vi, pp. 163-4, and not to Achnanthes.

I have also stated in 'Micr. Journ.,' vol. vi, p. 195, that the *Entopyla australis* of Ehrenberg ('Berlin Proceedings,' 1848, p. 7) was perhaps the same as my *Gephyria incurvata*, from Ichaboe, or, at least, partly so. I arrived at this conclusion principally from supposing that Ehrenberg's sample of guano was not from Patagonia, as he had been informed, but from Ichaboe. Fig. 10, however, of Mr. Johnston's, taken from specimens from Patagonian guano, so far as I

* Smith's 'Syn.,' vol. ii, p. 93.

† 'Micr. Jour.,' vol. iv, t. v, f. 3.

can judge from the sketch unaccompanied by the description, or notice of the number of costæ in ·001, agrees perfectly with *Gephyria incurvata*, so that presumptive evidence is strongly in favour of the propriety of reducing my Gephyria to Entopyla, and to this conclusion I some time since had arrived; but on again examining with great care what Ehrenberg says, I am now compelled to relinquish this idea, and shall here quote from Ehrenberg, as translated in the 'Ann. Nat. Hist.,' 1848, p. 343: "It (Entopyla) forms quadrangular plates, which, seen from the side, are rounded off above and below. These quadrate tablets or boxes consist of several leaves like a book, which, however, are perfectly connected. The leaves are parallel with the narrow sides and curved; the two external leaves are like the cover of a book, thicker, and marked with thirty-two longitudinal ribs. The concave outer leaf is upon the ventral side, since it exhibits two large roundish apertures at the extremities; the opposite convex leaf has no aperture; all the intervening leaves have a large aperture in the centre, leaving only a thin margin; thus forming a large continuous space in the interior of these little boxes. The structure of Biblarium (Tetracyclus of Smith) is similar."

He adds, under the specific character: "In adult specimens the middle leaves are almost (*fere*) sixteen in number, the costæ of the lateral leaves more than forty, separated by a flexuous median line." From Ehrenberg in these descriptions speaking of middle and outer leaves, without any other distinction than those indicated, it appears to me that all these were similar in general appearance; in short, that the middle leaves were what Smith calls annuli, as in Rhabdonema and Tetracyclus, and not merely the connecting zone, dividing into lamellæ or thin slices, as are seen in some species of Amphiprora, &c. Now Gephyria differs from Eupleuria by the want of these cellulate annuli, and if Ehrenberg's description can be relied on, and it is too detailed to admit of a doubt, his *Entopyla australis* can neither be a species of Gephyria nor any species of Eupleuria known to me, and a question may even arise if it belong to Eupleuria at all; it seems a connecting link between Eupleuria and Rhabdonema, from which last it is distinguished by the dissimilarity of the valves or outer leaves of Ehrenberg.

As to that from Elide guano, fig. 9, I have only examined one perfect frustule and a few valves. It was first brought under my notice in September, 1858, by Mr. A. M. Edwards, of New York, who then informed me that he had detected it in guano from Elide Island, California, about eighteen

months previously, and had distributed it under the MS. name of *Scapha clathrata*. Mr. Edwards at once recognised from my description the identity of his Scapha with my Gephyria, and it is in consequence of his strong remonstrance against the union also of Entopyla that I have now revised the whole subject, and have stated my opinion as above.

In the Elide guano form, it is doubtful whether Mr. Johnston speaks of the dots or of the costæ, when he says there are 26 in ·001; probably of the former, for, according to my measurement, there are only 11 costæ in ·001 in all my specimens. So that in this respect it is intermediate between *G. incurvata* and *G. Telfairiæ*. In general appearance it resembles the latter more than the former, but the valves are much more obtuse than in any specimen of the species from Mauritius. How far these are sufficient marks of distinction I have not materials to decide. If these two be admitted as different, the one I indicated ('Micr. Journ.,' vol. vi, p. 164) from the west coast of Australia may prove a fourth; and I have observed valves of the same genus from other places, but about which I can offer no opinion without seeing perfect frustules. On some future occasion I may have it in my power to elucidate all the species more than I can do at present.

Gephyria, *Arnott* (nov. gen.)

Frustules arcuate, attached (not? forming a continuous filament), destitute of cellulate annuli and septa; connecting zone sub-lamellate, finely striate on the surface. Valves arcuate, with one median and several lateral costæ, dissimilar: inferior with the costæ disappearing below the extremities of the valve; superior with them reaching the extremity.

1. *G. incurvata.*—Costæ on the valve about 7 in ·001. *Eupleuria incurvata*, Arnott; *Acnanthes costatus*, Johnston.

Hab. Ichaboe (in guano); St. Simon's Bay, South Africa; Patagonia (in guano).

2. *G. media.*—Valves obtuse; costæ 11 in ·001. *Scapha clathrata*, Edwards, MS.; *Achnanthes angustata*, Johnston (not of Greville).

Hab. Elide Island, California (in guano).

In Botany *clathrate* implies that there are openings between the costæ, so cannot with justice be applied to this species.

3. *G. Telfairiæ.*—Valves cuneate, and acute at the extremities; costæ 15 in ·001.

Hab. Mauritius.

To prevent mistakes may I recommend to your readers to strike out from vol. vi, p. 89, line ten from the bottom, the words "or striate," which are intended to apply to *Eupleuria incurvata*, since removed to Gephyria.

The FUNDAMENTAL PROPOSITION *in the* THEORY *of* ABERRATION (*in Refraction*) *at a* CURVED SURFACE SIMPLY DEMONSTRATED; *and a* TEST ESTABLISHED *whereby the* INSUFFICIENCY *of the* APPROXIMATE FORMULÆ (*now in use*) *for* CALCULATING *the* ABERRATION *at a* SPHERICAL GLASS SURFACE *may be* CORRECTLY ASCERTAINED. By H. M.

IN the following paper I propose to treat on a subject of great importance to working opticians, and which appears to me to have been not very successfully handled by writers on Optics.

Instead of giving a decided answer to the question I propose to solve, mathematicians have hitherto considered it sufficient to offer an approximate solution, supposed to be correct enough for practical purposes. This is a point on which I entertain a doubt, and my object in the present paper is to give a completely satisfactory answer to the question proposed, and to show, by an example, illustrating the formula deduced, how far the usual approximation falls short of the truth—in an extreme case.

I have added a geometrical proof of the truthfulness of the formula, which may contribute to excite attention to a subject the difficulty of which has, I think, been unnecessarily magnified.

For convenience I have also appended the arithmetical working of the example.

Although I have not Potter's book at hand, the correctness of the substitution of the figures in his *formula*, which is identical with Sir J. Herschel's in 'Encyclop. Metrop.,' and Wood's, &c., may be relied on.

PROBLEM.

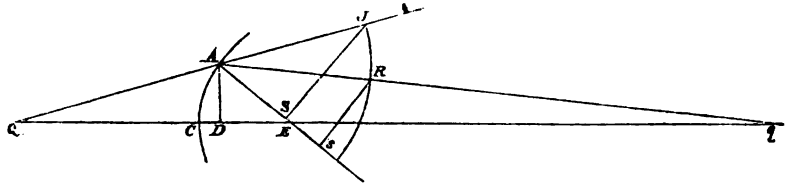
Trace *accurately* the course of a given ray of light, QA, after refraction at a *given point*, A, on the surface of a *given*

solid, of which AC is a section in the plane of refraction, QCq being its axis. The refractive index $= m$.

Here QC is given.

Also CD and DA co-ordinates of the point A.

Hence, also, the normal AE and subnormal DE may be found.



Let Aq be the refracted ray required, cutting QCq in q.

Now sin inc. : sin E :: QE : QA.

sin E : sin refr. :: qA : qE.

$\therefore$ sin inc. : sin refr. :: m : 1 :: $\frac{q\text{A}}{q\text{E}} : \frac{\text{QA}}{\text{QE}}$.

$$\therefore \frac{q\text{A}}{q\text{E}} = \frac{m \cdot \text{QA}}{\text{QE}} = c \text{ (a known quantity).}$$

$$\therefore q\text{A}^2 = c^2 \cdot q\text{E}^2.$$

i.e. $q\text{E}^2 + \text{EA}^2 + 2q\text{E} \cdot \text{ED} = c^2 \cdot q\text{E}^2$.

$$\therefore (c^2 - 1)\, q\text{E}^2 - 2\text{ED} \cdot q\text{E} = \text{EA}^2.$$

$$\therefore \quad q\text{E}^2 - \frac{2 \cdot \text{ED}}{c^2 - 1} \cdot q\text{E} = \frac{\text{EA}^2}{c^2 - 1}.$$

$$\therefore \left\{ q\text{E} - \frac{\text{ED}}{c^2 - 1} \right\}^2 = \frac{\text{ED}^2}{(c^2 - 1)^2} + \frac{(c^2 - 1)\text{EA}^2}{(c^2 - 1)^2}.$$

$$\therefore \quad q\text{E} = \frac{1}{c^2 - 1} \left\{ \text{ED} \pm \sqrt{\left\{ \text{ED}^2 + (c^2 - 1)\text{EA}^2 \right\}} \right\} \text{QEJ}.$$

Let AC represent a section of a spherical surface (rad $=$ EC). The lines CD, AD, DE are given in the tables. Whence find QA and QE; Let $m = \frac{3}{2}$.

Ex. 1. Let AC $= 40°$ AD $= \cdot 64279$ (by tables.)

QC $= 2$ inches $\therefore$ AD$^2 = \cdot 4131789841$

CE $= 1$ inch ED $= \cdot 76604$ (by tables.)

QE 3 inches $\therefore$ QA $= 2 \cdot 324598$

$\therefore \quad c = 1 \cdot 162299$

$\therefore \quad c^2 = 1 \cdot 350938965401$

$$\therefore q\text{E} = \frac{1 \cdot 73442}{\cdot 350928965401} = 4 \cdot 94226 \text{ inches}$$

$\therefore q$C $= 5 \cdot 94226$ inches.

Ditto by Potter's Formula (second approximation).

$$\frac{3}{2u'} = \frac{\frac{3}{2}-1}{1} - \frac{1}{2} + \frac{y^2}{2}\left(\frac{\frac{1}{2}}{(\frac{3}{2})^2}\right)\left(1+\frac{1}{2}\right)^2\left(\frac{\frac{3}{2}+1}{2}+1\right)$$

$$\therefore \frac{1}{u'} = \frac{3}{8}y^2 = \frac{1{\cdot}23954}{8}$$

$\therefore u' = 6{\cdot}452$ inches,

but $Cq = 5{\cdot}942$, as found above.

$\therefore$ Error by approximation = ·51 inches in excess.

ARITHMETICAL WORKING.

$$c = \frac{m\mathrm{QA}}{\mathrm{QE}}$$

$\mathrm{EC} = 1{\cdot}00000$
$\mathrm{ED} = \cdot 76604$

$\therefore \mathrm{CD} = \cdot 23396$
$\therefore \mathrm{QD} = 2{\cdot}23396$

$\mathrm{QA} = 2{\cdot}324598$

$$c = \frac{3}{2}\cdot\frac{2{\cdot}324598}{3}$$

$$= 1{\cdot}162299$$

$\mathrm{AD} = \cdot 64279$
$\cdot 64279$

578511
449953
128558
257116
385674

$\mathrm{AD}^2 = \cdot 4131789841$

$2{\cdot}23396$
$\mathrm{QD} = 2{\cdot}23396$

1340376
2010564
670188
670188
446792
446792

$\mathrm{QD}^2 = 4{\cdot}9905772816$
$\mathrm{AD}^2 = \cdot 4131789841$

$\mathrm{QA}^2 = \mathrm{QD}^2 + \mathrm{AD}^2 = 5{\cdot}4037562657$

4
43)140
129
462)1137
924
4644)21356
18576
46485)278026
232425
464909)4560157
4184181
4649188)37597600
37193504
404096

$$
\begin{array}{rr}
c = & 1{\cdot}162299 \\
 & 1{\cdot}162229 \\
\hline
 & 10460691 \\
 & 10460691 \\
 & 2324598 \\
 & 2324598 \\
 & 6973794 \\
 & 1162299 \\
 & 1162299 \\
\hline
= & 1{\cdot}350938965401 \\
\hline\hline
\end{array}
$$

$$
\begin{array}{rr}
\therefore c^2 - 1 = & {\cdot}350938965401 \\
ED = & {\cdot}76604 \\
 & {\cdot}76604 \\
\hline
 & 306416 \\
 & 4596240 \\
 & 459624 \\
 & 536228 \\
\hline
ED^2 = & {\cdot}5868172816 \\
(c^2 - 1)\ EA^2 = & {\cdot}350938965401 \\
\hline
ED^2 + \overline{c^2 - 1} \cdot EA^2 = & {\cdot}9\dot{3}7\dot{7}5\dot{6}2\dot{4}7\dot{0}0\dot{1}(\cdot968378 \\
 & 81 \\
\hline
186) & 1277 \\
 & 1116 \\
\hline
1928) & 16156 \\
 & 15424 \\
\hline
19363) & 73224 \\
 & 58089 \\
\hline
193667) & 1513570 \\
 & 1355669 \\
\hline
1936748) & 15790101 \\
 & 15493984 \\
\hline
 & 296117 \\
ED = & {\cdot}76604 \\
\sqrt{ED^2 + \overline{c^2 - 1}EA^2} = & {\cdot}968378 \\
\hline
ED + \sqrt{ED^2 + \overline{c^2 - 1}EA^2} = & 1{\cdot}734418 \\
\hline\hline
\end{array}
$$

$$qE = \frac{1{\cdot}734418}{{\cdot}350938965401} \doteq 4{\cdot}94222 \text{ inches.}$$

·350938965401)1·734418000000(4·94222
1 403755861604
3306621383960
3158450688609
1481706953510
1403755861604
779510919060
701877930802
776329882580
701877930802
744519517780
701877930802
426415869780

We learn, by a subsequent communication from H. M., that he has tried other arcs, as 15° and 10°, by the above test, and finds that the error of the Formulæ of Approximation in these cases exceeds that which is here proved to exist in the arc of 40°.

He has also found that Mr. Potter's *third* approximation is incorrect as well as the *second*, which is given in the Example.

On the Markings *of* Diatomaceæ.

By Thos. G. Rylands, Esq.

It is not easy to over-estimate the importance of the department "Notes and Correspondence" in your Journal. Not only does it afford a means of recording facts which might otherwise remain unpublished; but the various hints and memoranda contained in it possess a value to the country student which those only who are similarly situated can appreciate. The note by Dr. Greville, "On a Structure observed in Surirella,' vol. vii, p. 116, recalled my attention to the subject of the present article, and reminded me that on two occasions I had observed something similar in naviculoid frustules. The first was in *Pleurosigma balticum*, where the internal marking was hexagonal; and the second in a frustule of *Amphipleura pellucida*, where there were transverse lines, but much more distant than the 130 to ·001″ observed in that species by the Hull microscopists.

In neither of these instances were the slides my own, and they were not seen under circumstances which enabled me to do more than record the fact of their occurrence. In neither case was the idea of *a septum* entertained; the internal markings had distinctly the curve of the side of the frustule, and the impression conveyed was simply that both surfaces of the silica were marked. I had the less hesitation in coming to this conclusion, from having frequently seen something similar, but apparently constant, in certain disciform species. The fact that certain species of *Actinocyclus*, &c., have two very evident sets of markings is generally known. It is hardly less probable that the same thing has been seen in *Coscinodiscus centralis*, and that the fine secondary markings of *Triceratium favus* (indicated by Dr. Wallich in what he calls *T. fimbriatum*) have been observed by those who have directed their attention to that species.*

It was while I was looking for the same thing in *Coscinodiscus radiatus*, that the importance of separating and distinguishing the several types of markings was impressed upon my mind. Until they are so distinguished, their real value as characters for purposes of classification must remain unknown. How far I have succeeded in this investigation remains to be proved, and when our knowledge will be sufficient for practical purposes depends upon the attention which observers may hereafter give to the subject. I may mention that so long as observation is confined to perfect specimens little progress will be made; fragments now and then occur happily placed at the right angle for the purpose, and convey more information at a glance than can be obtained in hours from the ordinary side or front view of a frustule.

With the hope that I may hereafter be in a position to enter more fully into this subject, I shall refer now only to those markings which bear upon the purpose for which this article is written.

The siliceous portion of diatomaceous frustules seems to be normally composed of two layers, more or less intimately combined. The connexion may be simple and entire, as in the case of *Pleurosigma angulatum*. Individual specimens of this species are far from uncommon, in which the outer "areolated" layer is partially removed, leaving the inner layer entire. Isolated portions of the

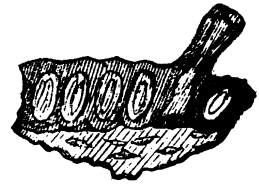
* 'Micr. Journ.,' vol. vi, p. 247, pl. xii, figs. 4—9. I need hardly add that the marginal fimbriæ and the minute processes at the angles of the hexagonal areæ also occur in British specimens of *T. favus*.

outer layer may be found upon the frustule, but I have never seen them separated; the force which removes them being apparently sufficient to break them up into single "areolæ:" the term in this case is very unfortunate, for they are in fact hemispherical elevations. In other cases the two layers are connected by septa arranged hexagonally, or otherwise, after the fashion of a closed honeycomb. This structure is figured by Dr. Wallich, in the article before referred to, as occurring in his so-called *Triceratium fimbriatum;* but he has overlooked the outer layer forming the lids of the cells. In this case, the surfaces, both external and internal, may be plane, or formed into slightly convex facets; they may be marked or otherwise. This is the *Coscinodiscus* type, and will be found with certain modifications in *Coscinodiscus, Eupodiscus, Aulacodiscus,* &c.

I find it difficult to avoid the conclusion that there are two distinct materials present in the composition of these layers, one of which acts much more powerfully upon light than the other.

Again, the two layers may be so developed and combined that the septa become, as it were, a skeleton in the more transparent substance. Take the case of *Eupodiscus Argus,* of which I have one or two most fortunate sectional views. The outer convex surface is formed of a layer of transparent silica produced into radiating lines of hemispherical projections; below this, and imbedded in the same material, are the "areolæ," which are composed of the denser substance, and are fragmentary or continuous, according to the size and perfection of the specimen. The internal surface of the valve is marked with minute dots. The following figures represent the forms described:

Eup. argus.
Side of a single areola.



Eupodiscus —— ?

Pl. angulatum.

The small secondary markings in *Triceratium* are probably simply elevations; but those of the connecting membrane, like the coarser markings of the sides of the frustules, follow the type of *Coscinodiscus.*

I have no positive evidence as to the nature of the material

with which the cell-like intervals between the septa are filled. Burnt specimens—which I have not—would determine if it be fluid. It is occasionally wanting, and then the cavities are filled with air. In the specimen of *Triceratium favus* referred to, a large proportion of the areolæ of the connecting membrane contain air-bubbles. My present impression is that the material is solid throughout.

There is a peculiarity very common, if not constant, in markings of the *Coscinodiscus* type, which, in most cases, is sufficient to determine it even from a front view alone. The internal layer, at the base of each areola, is modified internally, so as to produce a dark or light spot, as the focal adjustment of the instrument is changed.

If the foregoing particulars be applied to the cases observed by Dr. Greville and myself, I think the solution is easy. It is not without some hesitation that I venture to throw the slightest doubt upon an observation made by such a man as Dr. Greville. Under ordinary circumstances I should certainly not do so; but since the publication of his article on Diatomaceæ in Californian guano, I am inclined to shelter myself under the supposition that his working instrument is not equal to the exhibition of these minutiæ. If this were not the case, we could hardly have been told that the rays of his *Spatangidum Ralfsianum* terminate "in a narrow lunate fold of the valve," nor would he have proposed to distinguish *Spatangidum* and *Asteromphalus* by the areolated and the granulated structure of their valves. In the first case the lunate fold has certainly no existence in nature; the appearance results from the elevation of the ray (as in *Aulacodiscus*) and the sudden depression at its termination. While, in the second case, there is really no structural difference whatever in the markings of the species described, at least as far as regards *S. Ralfsianum* and *A. flabellatus*, both of which follow precisely the *Coscinodiscus* type; the latter, however, being considerably finer, requires a proportionate increase of power.

Some Observations on the Structure *of* Nerve-Fibres.

By Joseph Lister, Esq., F.R.C.S. Eng. and Edinb., Assistant-Surgeon to the Royal Infirmary of Edinburgh; and William Turner, Esq., M.B. Lond., Senior Demonstrator of Anatomy in the University of Edinburgh.

Having recently had the opportunity, through the kindness of Mr. Lockhart Clarke, of inspecting some of his beautiful preparations of the spinal cord, we were struck with an appearance which had not yet received a satisfactory interpretation; and, having been induced to investigate the point, we have met with some facts which seem of sufficient interest for publication.

For the sake of clearness it may be well to state briefly the method employed by Mr. Clarke in preparing his specimens.

A portion of perfectly fresh spinal cord having been hardened by steeping in dilute chromic-acid solution, thin sections are made with a razor, and these, after immersion for a while in an ammoniacal solution of carmine, are soaked in spirits of wine to remove the water, and then treated with oil of turpentine. The last-named agent has the effect of rendering the sections transparent, so that the nerve-cells of the gray matter, finely coloured by the carmine, are seen with the utmost distinctness, giving off in various directions long branching processes; while the nerve-fibres, which are similarly tinted, may be traced with equal facility in their course through the cord.

In the preparations which we saw, the cord had been sliced crosswise, and in the columnar regions, where the nerve-fibres have for the most part a longitudinal direction, the transverse section of each fibre showed itself as a carmine-coloured point, surrounded by a perfectly pellucid and colourless ring. This was the appearance which seemed to demand explanation; the question being whether the transparent ring was a mere space, resulting from shrinking of the object during the preparation, or the white substance of Schwann (medullary sheath) rendered transparent by the turpentine, the axial cylinder alone, in that case, having received the carmine colour.

It occurred to us that the point might probably be determined by applying a similar mode of preparation to some nerve the dimensions of whose fibres could be readily ascer-

tained. With this view we steeped in chromic acid portions of the sciatic nerve of a cat just killed, and also parts of the spinal cord of the same animal; and having allowed them to remain between three and four weeks in the solution, we commenced the investigation in July of the present year, 1859.

A transverse section of the hardened sciatic nerve having been placed for a time in the carmine solution and then dried, we submitted it, without the application of turpentine, to microscopic examination with a power of 130 diameters. Viewed by transmitted light, it appeared as a confused opaque mass; but, by reflected light, it exhibited the structure depicted in Pl. II, fig. 1,* each nerve-fibre presenting in its section a carmine spot, surrounded by a yellowish-white, somewhat granular ring, which, though doubtless corresponding to the pellucid rings in the preparations of the cord before alluded to, was clearly composed of some solid material, in short of the white substance of Schwann altered by the action of the chromic acid.

We next examined sections of the cord treated in the same way, but found that these dry specimens were so incrusted with carmine that they gave no definite results. It happened, however, that one of the sections treated with carmine still remained moist, and, after washing away all superfluous colouring matter, we examined it by transmitted light. A very beautiful appearance now presented itself; carmine points being seen in the columnar regions, as in Mr. Clarke's preparations, surrounded by rings; but the latter, instead of being transparent like mere spaces, were dead white; the carmine points, on the other hand, appearing in the thinnest parts of the section as illuminated spots amid the general opacity. This is represented in fig. 5.

It will be seen from this sketch, which is drawn on the same scale as fig. 1, that the nerve-fibres varied very much in their diameter, the largest being of about the same size as those of the sciatic nerve, while others were of extreme minuteness; but in all cases in which they were sufficiently large to be distinguished, they had the same character of a white circle with a central carmine spot from one fourth to one third the diameter of the whole fibre. It was obvious that, in the cord, as in the sciatic nerve, the carmine central part of each fibre was the axial cylinder, and the opaque circumferential portion the medullary sheath; and, therefore,

* This sketch, like the others illustrating this paper, was drawn by means of the camera lucida.

that the pellucid rings in preparations treated with turpentine consisted of the white substance rendered transparent by that reagent.

The point at issue was thus satisfactorily decided; but for the sake of confirmation we made some further observations, the results of which seem deserving of mention.

On examining the hardened sciatic nerve, without tinting the preparations with carmine, we found that in extremely thin slices the transverse sections of the nerve-fibres, viewed by transmitted light, appeared as brownish rings with central transparent colourless spots (see fig. 3), whilst by reflected light the central parts appeared black, as shown in fig. 2. In fact, under a low power the axial cylinders had, in these specimens of the sciatic nerve, as much the appearance of mere spaces as the medullary sheaths had in preparations of the cord treated with turpentine. But on applying a fine glass of high power, a granular appearance was disclosed in the pellucid central portion, showing that it was in reality a solid substance, though of a transparency which was very remarkable, considering that it had been so long subjected to the action of chromic acid; and on afterwards treating similar sections with carmine we found that this part alone became coloured. The higher magnifying power also brought out an appearance of irregular concentric lines in the brown* medullary sheath; and this, together with the granular aspect of the axial cylinder, is represented in fig. 4.

These facts afford a very striking illustration of the essential difference in chemical composition between the axial cylinder and the medullary sheath; the former being totally unaffected by chromic acid, though the latter is rendered opaque and brown and concentrically striated under its influence, while, on the other hand, the axial cylinder, after being subjected to the action of chromic acid, imbibes the carmine colour with peculiar facility, although the medullary sheath is entirely untinged by it.†

We next applied the high magnifying power to extremely thin slices of the spinal cord prepared in the same way. In transverse sections of the columnar regions the white

* It must be mentioned that a similar brown colour is seen in the superficial parts of a cord which has been steeped in chromic acid, but the deeper portions of the organ are comparatively only slightly coloured, so that in individual nerve-fibres seen under a high magnifying power the brown tint is not observed.

† In a boiled fresh nerve also the medullary sheath remains unaffected by ammoniacal solution of carmine, while the axial cylinder assumes a distinct though very faint pink tint.—J. L.

substance of Schwann presented, in the larger fibres, the same concentrically arranged appearance as we had observed in the sciatic nerve, as is illustrated by figs. 6 and 7, of which fig. 6 is one of the largest met with, being $\frac{1}{300}$ of an inch in diameter, while fig. 7 is as small as $\frac{1}{3000}$ of an inch in transverse measurement. In the very minute fibres no appearance of concentric lines could be detected, yet, wherever the existence of an axial cylinder was indicated by a carmine point, a ring of medullary sheath was always visible, presenting the same proportion to the axial cylinder as in fibres of larger size. This may be gathered from figs. 8, 9, and 10, of which fig. 8 measures $\frac{1}{3000}$ of an inch across, fig. 9 $\frac{1}{8000}$, and fig. 10 only $\frac{1}{14000}$.

At the margins of longitudinal sections of the cord, the contrast, both in structure and in tint, between the axial cylinder and the medullary sheath showed itself very beautifully. It often happened that a projecting isolated fibre was, near its extremity, more or less divested of the white substance of Schwann, so that the delicate, carmine-tinted axial cylinder was exposed, though presenting here and there colourless flakes of the medullary sheath adhering to its surface; while in parts where the nerve was still entire, the pink colour of the central fibre could be distinctly discerned through the intervening white substance. Fig. 11 represents a large fibre under such circumstances, and fig. 12 one of considerably smaller size; and these sketches also display the remarkable fibroid arrangement which we find the white substance of Schwann invariably assumes under the influence of chromic acid.

In conclusion, we may remark that the successive employment of chromic acid and carmine seems likely to afford valuable aid in discriminating nerve-fibres among other structures; there being, so far as we are aware, no other form of tissue which, after the use of these means, exhibits fibres having a central carmine axis, and peripheral uncoloured sheath.

Supplementary Observations by Mr. Lister.

The fibroid arrangement of the white substance of Schwann in nerves hardened by chromic acid has been minutely described by Stilling, in his elaborate treatise on the 'Nerve-fibre and Nerve-cell,'* a work which we had not seen when

* 'Ueber den Bau der Nerven-Primitivfaser und der Nervenzelle.' Von Dr. B. Stilling. 1856.

the foregoing communication was written, but a copy of which was kindly lent me by Professor Goodsir, soon after Mr. Turner had left Edinburgh for the vacation. According to Stilling, the medullary sheath is, even in perfectly fresh nerves, composed of a network of fibres, which are continuous with others in the axial cylinder and in the proper investing membrane; so that, in his opinion, these three constituents of the nerve-fibre differ from each other only in the manner in which their elements are disposed.* This view is not only quite novel anatomically, but is opposed to the generally received physiological opinion, that the axial cylinder is the essential part of the nerve-fibre, and the medullary sheath an insulating investment. Considering the high estimation in which the writings of Stilling on the anatomy of the nervous centres are deservedly held, and the influence which therefore attaches to his opinions, it seems fortunate that we have been able to present so clear a demonstration that the axial cylinder is chemically as well as morphologically totally distinct from the medullary sheath.

With regard to the cause of the fibroid arrangement of the medullary sheath, an observation which I happened to make several years ago, regarding the aggregation of fatty matter, may perhaps tend to throw light upon the subject. I submitted to microscopic examination some of the pultaceous slough of a sore affected with hospital gangrene, thinking it possible that I might discover in it some fungus which might account for the peculiar specific character of that disease; and found in it numerous bodies, each composed of branching fibres radiating from a common centre, and looking, at first sight, like some sort of vegetable growth, so that I made careful sketches of them, one of which is reproduced in fig. 13. But seeing afterwards, in the same object, some bundles of acicular crystals of margarine, having a distant resemblance to the bodies I had drawn, I added ether to the specimen, and found that it dissolved the latter equally with the former. This showed that what first attracted my attention was merely an arborescent form of aggregation of some fat, probably margarine; and it seems not unlikely that the fluid fat which exists in the medullary sheath of a perfectly fresh nerve, may tend to a similar arrangement of its particles when passing into the solid form, and so give rise to the appearance in question. It is to be remarked that the fibroid character is not peculiar to specimens treated with chromic acid, but also shows itself, though in a less perfect manner, in nerves which have been subjected to other modes

* Op. cit., p. 6.

of preparation—for example, after exposure for a few seconds to a temperature of 212° F.

There is another important statement made by Stilling, which the use of the method of examination above described enables me to correct. He speaks of the fibres which connect one nerve-fibre with another as similar in every respect to those seen in the medullary sheath.* I find, however, that both in the sciatic nerve and in the spinal cord of the cat, the connective tissue between the nerve-fibres, like the neurilemma and pia mater, with which it is continuous, becomes coloured by the carmine; whereas, the medullary sheath, as before stated, is quite unaffected by it, proving that the two structures are chemically distinct from one another. In both these situations, too, the fibres of the connective tissue are much more delicate than the constituents of the medullary sheath, which are often comparatively coarse, as may be seen from fig. 11. In the columnar regions of the cord, the former require a high magnifying power to be applied to very thin sections, in order to distinguish them, and are often present in such extremely small quantity that, without very careful examination, the nerve-fibres appear actually in contact with one another. In the sciatic nerve I have observed occasional elongated nuclei in the connective tissue.

I may add that glycerine has proved very useful, not only for permanently preserving the preparations in the moist state, but also as an aid to investigation; for it renders the sections much more transparent, without making the white substance of Schwann invisible, as turpentine does; and hence the course of the nerve-fibres through the cord can be traced much more easily, and, at the same time, the proportion between the medullary sheath and axial cylinder can be readily ascertained. Thus, by examining transverse sections of the cord in this way, I find that while Kölliker is quite correct in his statement that the fibres of the roots of the nerves diminish in size in passing inwards through the columnar regions,† yet the diminution affects only the white substance; the axial cylinder often retaining its full dimensions even in the middle of the gray matter, while the medullary sheath is reduced to a very thin crust, so that the nerve-fibre assumes a character differing but little from that of an offset of a nerve-cell.

* Op. cit., p. 7.

† Kölliker's 'Handbuch der Gewebelehre,' 3d edit., p. 735.

On some Histological Features *in the* Shells *of the* Crustacea. By Professor W. C. Williamson, F.R.S.

In the Report of the British Association for 1848, Dr. Carpenter called attention to the fact that the tegumentary shell of the common crab chiefly consists of a tubulated structure closely resembling dentine. Since the publication of that report, the subject has been further investigated by Professor Quekett ('Lectures on Histology,' vol. ii, 1854), and by Professor Huxley ('Cyclopædia of Anatomy and Physiology,' art. Tegumentary Organs, 1855-6). Each of these later writers have contributed much to our previous stock of information on this subject. But as discrepancies exist between the conclusions at which they have arrived, a new investigation of the matter became desirable; hence the present communication.

Dr. Carpenter has described the shell of the crab as consisting of three layers. "1st, a horny structureless layer covering the exterior; 2d, a cellular stratum; and 3d, a laminated tubular substance." Mr. Huxley points out in addition the existence of a soft uncalcified laminated structure, lining the inner surface of the shell; consisting, in fact, of similar layers to those external to it, but not yet calcified. My examination of the shell of the common crab confirms Professor Huxley's conclusion that it consists of *four* horizontal textures. Both Professors Carpenter and Huxley describe the outermost one as *horny*, but it is obviously calcareous, disappearing much more completely under the action of solvent acids than any of the others. The second or "cellular" layer of Dr. Carpenter is that respecting which the chief difference of opinion exists. Professor Huxley denies the "cellular" character attributed to it by Carpenter and Quekett, affirming that the cell-like areolæ result from a peculiar additional deposit of calcareous matter in the uppermost layers of the shell. With this conclusion I thoroughly agree, since oblique sections of the layer demonstrate that the areolæ, which in their superficial aspect so closely resemble epithelial cells, sink deeply into the substance of the shell, gradually becoming less distinct and definite as they descend into its lower laminæ.

Dr. Carpenter and Lavalle have designated the outermost of these layers "the structureless epidermis;" but I would

prefer applying to it the name of *pellicle*, since it only constitutes a small portion of the true epidermal tissue of the crab. In like manner I would designate the second, the *areolated* layer, instead of employing Carpenter's term *cellular*, which implies what appears to be erroneous. The third, tubulated layer, which all the above writers have shown closely to resemble dentine, may be designated the *calcified corium*, whilst the innermost layer described by Professor Huxley may be called the *uncalcified corium*.

It is unnecessary again to describe the arrangement of these layers. Dr. Carpenter has pointed out the tubulated structure of the corium, and the inflections of its laminæ, which at numerous points ascend like flat-topped cylindrical pillars, penetrating the areolar layer, and reaching the pellicle, where they occasion the white spots seen on the exterior of the crab's shell.

The areolæ of the second layer, when viewed superficially, present various aspects. Ordinarily they appear in the form of dotted hexagonal spaces separated by translucent lines, the former having defined outlines, which are darkest on the side remote from the light, indicating projection and the formation of a shadow. In other cases the areolæ are of a lighter hue than the intervening lines, which are dark and defined. Oblique sections of these latter varieties show that at a very little depth below their outer surface the dark lines pass into others which are lighter than the areolæ; and still deeper down, the areolæ themselves become so merged, that all distinct areolation ceases to be visible. These facts indicate that the areolation is due to some conditions affecting the surface of the areolated layer on the line of junction between it and the pellicle. That this is the case will be demonstrated by an examination of some other forms of Crustaceans.

When viewed superficially, numerous vertical tubules are seen in the areolæ. When a thin vertical section has been quickly mounted in hot Canada balsam, so as to prevent the latter from displacing the air in the tubules, these are sufficiently conspicuous. The entire layer is seen to be composed of very thin laminæ which follow the inflections of the surface of the subjacent corium, and the direction of these tubules is affected by the curves of the laminæ, which they penetrate nearly at right angles. On approaching the projecting pillars of the corium, the areolated laminæ bend up[illegible], parallel with the sides of the pillars. Whether or [illegible]e former are continued across the circular extremities [illegible] latter in a very thin and non-areolated state I am

unable to determine, but I am disposed to believe that they do.

We often find a third modification of the areolæ, in which the centre of each is occupied by a dark radiating spot resembling a stellate pigment-cell; and I have occasionally seen in the common crab, a form identical with that seen by Professor Quekett in a species of Portumnus, and which he describes as consisting of "hexagonal cells having thick walls" ('Lectures on Histology,' vol. ii, p. 393). No doubt exists on my own mind that all these are mere varieties dependent on slight modifications of the calcific process.

Pl. III, fig. 1, presents a diagram of the arrangement of the layers in the shell of the crab; *a* being the pellicle; *b*, the areolated part with its small tubules; *d*, the calcified corium with its cylindrical pillars and vertical tubuli; and *f*, the uncalcified corium. Recalling what I have said respecting the tendency of the tubuli in the areolated layers to assume directions perpendicular to the plane of the laminæ which they penetrate, a glance at the diagram will explain the "radiated cells" of Professor Quekett, which he describes as surrounding the pillars of the corium (loc. cit., vol. ii, fig. 256). In any horizontal section of these structures, the tubuli at a distance from the pillars would be intersected at right angles to their direction, whilst near the pillars, owing to the change in the plane of the component laminæ, the tubules would be intersected nearly in the direction of their length. Hence the appearance of radiating lines in which Professor Quekett could detect no cell-wall, and which he found so difficult to reconcile with his idea of cellular structure.

The upper laminæ of the corium are thicker than the lower ones; and the undulations of the penetrating tubuli, so characteristic of crustacean structures, appear to be definitely related to the laminæ through which they pass. Towards the upper part of each pillar, the tubuli bend outwards from the same reason that those of the contiguous areolæ are deflected from a perpendicular line, viz., the tendency to penetrate the laminæ at right angles to their plane. I have not detected any branching forms amongst these tubuli, though Professor Queckett thinks that he has observed such.

Beneath the calcified corium is the thin *un*-calcified layer of the same tissue, which would ultimately have become calcified, as fresh laminæ were applied to its inner surface. When detached from the calcified shell, which is readily done, it presents numerous granular specks, which obviously correspond with the tubuli of the calcified tissue. I have found

it impossible to satisfy myself whether or not these present open apertures prior to calcification; their minuteness and the refraction of light which they occasion rendering the determination of this point one of extreme difficulty. On the peripheral surface of this membrane are numerous reniform specks having a reticulated aspect. The reticulations resemble cells, and are not unlike the areolæ of the areolar layer; but I believe them to be mere corrugations of the membrane. The specks correspond with equally numerous calcareous projections from the inner surface of the calcified corium. On making a horizontal section of this surface, the projections are seen to be perforated by larger and more sparse tubuli than the contiguous shell, and which display a disposition to areolation similar to what occurs in the corresponding parts of the uncalcified corium. In other portions of the same section, patches are often met with, unconnected with the specks just referred to, in which there is also a marked disposition towards areolation, as seen in Pl. III, fig. 2. These areolæ are sometimes hexagonal, but at others so irregular as to preclude all idea of a cellular origin. *The translucent reticulate lines separating the areolæ being merely spaces from which the tubuli are absent.*

Throughout the entire shell we find dispersed some cylindrical bodies which are either fibres or larger tubuli. These penetrate all the layers of the shell. Tubuli similar to these are very numerous in the structureless portions of the pellicle immediately above the flattened summits of the pillars of corium, from which they ascend to the surface of the pellicle.

Before discussing the moot questions between the observers already quoted, I would direct attention to some other structures calculated to throw light on the debated points.

On making a vertical section of the tegument of the common shrimp, we find the same number of layers as in the crab, but in a much more attenuated form; but we have also some new conditions of interest, some of which have already been pointed out by Professor Huxley.

The areolar layer displays innumerable delicate areolæ (fig. 3), like those in the crab, but fainter in outline; both these and the corium appear granulated in the horizontal sections, either as the result of vertical fibrillation or from tubuli. M. Lavalle has denied the existence of tubuli even in the corium of the crab.

Professor Huxley rejects his conclusions in that instance, but thinks him right in the case of the shrimp, where he believes the granules merely indicate vertical fibrillation;

my vertical sections, mounted in Canada balsam, appear to oppose this idea. Some, at least, of these lines are filled with air, indicating a tubular structure.

The very thin areolated layer is not so readily distinguished from the corium in the vertical section as in some other Crustacea, but I have obtained several evidences of its separate existence as in the crab. The most remarkable feature in the integument of the shrimp consists of numerous discs, the result of a secondary calcification, which becomes incorporated with the pre-existing tubulated calcific deposit. Each disc commences as a faint brownish ring, within which the areolæ are at first visible, but the centre shortly displays signs of consolidation, as in fig. 4; in which example the deposit has commenced at the root of one of the short hairs so abundant on this tegument.* The small discs thus originated increase both in breadth and thickness, but especially the former. Some of them assume the aspect of figs. 5 and 6, where the dark radiating lines indicate a condition of the calcareous matter resembling what is seen at the first formation of the disc, and different from what occurs in the intervening translucent parts, which appear to be more consolidated. A translucent crucial figure is often seen in the centre of each disc. But in the majority of instances, as already pointed out by Professor Huxley, the discs assume the aspect of fig. 7. Here the centre consists of numerous small concretionary granules, each commencing as a separate point, but which grow and coalesce by external concentric additions until they unite to form a solid translucent calcareous disc—strongly reminding us of what is seen in the pulp-cavities of cetacean teeth. In fig. 8 some of these granules are detached from the disc. When a portion of the integument of the common shrimp is boiled in a solution of caustic potass, though the soft chitinous element is not destroyed by the process, it undergoes some change, revealing an organic structure which does not hitherto appear to have been noticed. The areolated layer seen in fig. 3 now presents the appearance represented in figs. 9 and 10. It consists of at least two layers of minute irregular concretions. Each of these corresponds in size with one of the unaltered areolæ, and I assume them to be identical, though unable to demonstrate the fact. Each concretion appears to be formed by the coalescence of a number of minor concretions. On examin-

* These hairs, which are tubular, are planted in uncalcified depressions in the areolar layer; a large branching tubule, ascending from below, penetrates all the layers of the integument, and, reaching the base of the hair, communicates with the canal running along its interior.

ing the free margin of any of the segments of the body after being treated with caustic potass, these granular concretions will be seen in various stages of development (fig. 10). Those nearest the free margin are small and isolated. As we recede from the margin the granules coalesce and become larger, receiving external additions, which cement them together, and finally producing the structure just described. The mode of calcification of the small areolæ and of the larger discs, though at first glance appearing so different, are thus demonstrated to be identical in all their essential features; though the process resulting in the large discs is obviously a secondary one, being preceded by that which forms the small concretions. The essential difference between the two lies in the greater extent of the calcific deposition in the former instance than the latter, as is proved by the effects of heat in occasioning contraction of those parts from which the larger discs are absent.

On decalcifying a portion of the integument thus treated by means of hydrochloric acid, it presents precisely the same appearance as the ordinary examples that have not been so treated. Two distinct granulations are now visible; one on the extreme outer surface of the membrane, apparently belonging to the pellicular layer, and the other in the areolated layer, if not also in the subjacent corium; the second being the tissue which I believe to be tubulated. The concretions represented in fig. 9 are absent from the points into which the tegumentary hairs of the shrimp are planted.

Many of the smaller species of decapod Crustaceans reveal modifications of structure throwing additional light on these tissues so interesting to the physiologist. A few of the more important varieties require notice.

In the British *Hyas araneus** we again meet with the four layers of integument. In the specimens examined, the pellicular layer alone presented a deep-red colour, and exhibited indisputable evidence that *it was composed of numerous exceedingly thin parallel laminæ*. The areolated layer was of a pale-yellow hue, and afforded equally clear proof that each areola is the dome-shaped extremity of a six-sided prism, the sides being contiguous with those of its neighbours, whilst its substance is traversed by longitudinal tubuli. Owing to the dome-like shape of the outer extremities of these prisms, the outer non-tubulated pellicle appears to dip down between

* I am indebted to my valued friend, Mr. Bean, of Scarborough, as well as to a still dearer relative, whose name has been long associated with the same place as one of its indefatigable naturalists, for the numerous specimens of British Crustacea upon which I have operated.

the areolæ, explaining the apparently intercellular reticulations seen both here and in the common crab, as well as in numerous other Crustaceans. The calcified and uncalcified portions of the corium are much more distinct here than in the common crab; since the former, instead of consisting of continuous layers of equal thickness, appears in the form of large hemispherical masses, the confluent bases of which are directed outwards, whilst their opposite convex surfaces project inwardly into a thick laminated uncalcified corium. The parallel laminæ of the corium continue their straight course equally through the calcified and uncalcified portions, demonstrating that the former are not secretions in the latter pushing aside its layer, but irregular calcifications of their substance. Tubular hairs are implanted in superficial depressions in the integument, at which points both the pellicular and areolated layers are wanting. The tube within the hair is continued downwards through the entire thickness of the corium, opening at its inner surface. A calcareous cylinder surrounds this canal, even where it passes through portions of corium otherwise uncalcified.

Similar, but still more strongly marked, conditions occur in *Pilumnus hirtellus*, a vertical section of part of the carapace of which is represented in fig. 11. *a* is the pellicular layer, which here (as is also the case in *Hyas araneus*) is the seat of the deepest colour. *b* is the areolar layer, displaying the dome-shaped areolæ with remarkable clearness. These domes are obviously portions in which the calcific matter has assumed different conditions to those under which it has been secreted in the superimposed pellicular layer. Each areola displays some very delicate vertical lines.* Whether or not these are tubes I have been equally unable to satisfy myself, here and in *Hyas araneus;* but, as I think that in *Portumnus depurator* there can be no question that the areolæ are tubulated, it is the more probable that the structure in question is also tubular.

Large hemispherical concretions occupy the upper part of the corium, the centre of each one of which is penetrated by a vertical canal, prolonged downwards through the uncalcified corium, but not surrounded in the latter part of its course by a calcareous cylinder, as is the case with *Hyas araneus*. Superiorly, each of these canals communicates with the base of a large tubulated hair implanted in a depression penetrating

* Seen to the left of the drawing; from the opposite portion of which they have been omitted, along with similar ones in the corium, to avoid confusing the other characteristic features of the structure.

the pellicular and areolar layers. These calcareous concretions display a coarse lamination, indicating the direction of the laminæ of the uncalcified corium, with which they are parallel. They are also penetrated by myriads of the usual undulating tubules, which appear to be prolonged, though less distinctly, through the uncalcified corium. I see no reason for doubting that the latter are tubuli as well as the former.

In a thin horizontal section of this integument, made through the upper part of the corium, which has been decalcified (fig. 12), we see delicate circular areas, with defined outlines and a central canal, indicate the position occupied by the calcareous concretions. This is important, since it shows that cell-like appearances may exist in the decalcified membrane, which, nevertheless, are entirely due to peculiarities of calcification; cells having taken no part in their origin.

Vertical sections of *Portumnus depurator* display even still more distinctly than the last Crustacean the dome-shaped cylinders of the areolated layer, and remove every possible doubt that could remain as to the *non-cellular* origin of this layer. The conclusion is inevitable, that the whole results from peculiarities attending the process of calcification. It is clear that in the Crustacea, two distinct co-existent calcifying processes are very commonly in operation, the one resulting in a more intense calcification than the other; their greater density and higher refracting power giving to the former the definite outlines seen both in the areolar layer generally, and in the lenticular discs of the shrimp.

Professor Quekett describes the areolated texture as conspicuous in the crayfish. I have only examined young specimens, but in them it was very indistinct, if not wholly absent. I found the four layers revealed in the vertical section (fig. 13), but the areolar layer (fig. 13 *b*) and the calcified corium (fig. 13 *d*) occupied the greater portion of the substance, the pellicle (fig. 13 *a*) and the uncalcified corium (fig. 13 *f*) being very thin. That which is the obvious homologue of the areolar layer in other Crustaceans is thick and very distinctly tubulated, the tubuli being distributed with the greatest uniformity. This layer would scarcely be distinguished from the subjacent calcified corium but for its greater translucency.

An anomalous example of the common lobster furnished new and interesting modifications of crustacean integument. The pellicular layer was so thin as to be scarcely traceable. The areolated layer, the chief seat of colour, was very distinct

both in the carapace and in the tail, though less so in the claws; but the chief interest lay in the calcified corium, especially at its peripheral portion. On looking at a vertical section, the tubulated structure of this layer was rendered confused and indefinite by some vague radiating elements. On making a horizontal section immediately below the areolar layer, the nature of these radiations became obvious. The entire section was covered with regular hexagonal areolæ of exquisite beauty (fig. 14). Each areola consisted of numerous irregular rods, radiating from a solid centre, subdividing like the outspread arms of an encrinite, a resemblance which higher magnifiers only rendered more obvious, since each radiating arm then appeared jointed; but this was an illusion. The whole was but a congeries of botryoidal rods (fig. 15), the result of a concretionary process of growth; the small tubercles with which each rod was studded being the homologues of those seen in the large calcareous discs of the shrimp. This structure was wholly distinct from the areolated layer of the integument. Between these stellate objects, there occasionally occur solidly calcified portions, often penetrated by a large vertical canal.

When a vertical section was decalcified, all these distinctive features disappeared. I now only saw a series of parallel chitinous laminæ, traversed by undulating vertical tubules; the line of separation between the areolated layer and the corium being very indistinct. Of these laminæ I counted about 60 in a section of the integument of the tail, whilst there were 120 in the claw of the same individual, showing that they are not consentaneously developed in all parts of the animal. On the external surface of the lobster's shell are numerous small depressions; at the hollow of each of these are the orifices of several vertical tubes which descend through all the subjacent tissues.

The hard calcified claw of the hermit crab further illustrates some of these points. A vertical section made through one of the numerous superficial tubercles (fig. 16) demonstrates that these latter are the homologues of the white spots on the shell of the common crab. We here see distinctly that the uplifted layers of the corium (*d*) pass through the areolated structure (*b*) and are brought into contact with the pellicle (*a*), whilst the corresponding thickened portion of the latter, here considerably thickened, is penetrated by tubuli or fibres (*e*) similar to those seen in the homologous portion of the common crab. This close relation of the upraised portions of the corium to the pellicle, and the absence of the areolar layer at such points, is also shown in *Hyas araneus*, *Portumnus*

depurator and *pusillus*, and numerous other forms, which illustrate an organization that attains its highest development in the common crab; whilst in *Portumnus depurator*, the diversion of the upper laminæ of the corium from their horizontality appears at its minimum.

Thus far it would appear that in all the Podopthalmous Crustaceans, the integument consists of four layers. An outer or superficial, almost structureless pellicle (*a*). An areolated layer (*b*), but from which the areolæ may be occasionally absent. A *calcified* corium (*d*), and an inner layer of uncalcified corium (*f*), which may become calcified as newer layers appear within it. Each of these layers varies exceedingly in the relative development attained, but traces of each of them always exist; each one becoming in turn the predominant element in the integument of the various Crustaceans. The corium appears to be more or less tubulated, whether calcified or uncalcified. The areolar layer is often, though perhaps less frequently so. Areolation does not appear to be confined to the "areolar" layer, since it occurs on a small scale in the corium of the crab and lobster; wherever it exists in the examples which I have recorded, either of corium or areolar layer, it is unquestionably the result of peculiar conditions under which the calcific matter is deposited, and not of cellulation. In the calcified corium of *Corystes Cassevilaunus*, we find an illustration of the secondary calcification to which areolation appears due. The lime exists in two distinct conditions; in the one it is equally diffused through the corium. But within this are large irregular masses of a totally different aspect evidently the result of a secondary process.

But Professor Huxley has already pointed out that areolation exists in the uncalcified membranes of the articulations of the claws of the common crab, where it cannot possibly be due to any process of calcification. In the latter example the areolæ appear to me to be tubulated portions of integument, and the intervening reticulate lines to be merely spaces from which the tubules are absent, as is unquestionably the case in the areolæ sometimes seen in the calcified corium of the common crab. Areolation appears to me invariably accompanied by tubulation, whilst the variations in the arrangement of these tubules, and the peculiar calcification which renders the areolæ so visible, appear to be common results of some single cause. What that cause is, remains to be ascertained.

There still remains for consideration the question of the origin of these various layers, and their relations to the deeper portions of the crustacean integument. Of course it

would be very desirable, were it possible, to examine each of these species immediately after it had cast its shell, tracing the various changes the new integument undergoes in its progress to maturity. Unfortunately, inland students have not the facilities for such inquiries enjoyed by their more fortunate fellow-labourers who dwell on the sea-coast; but it occurred to me that much of the requisite information might be obtained from the hermit crab. As is well known, the claws of this species are as thoroughly calcified as those of any other Crustacean. The anterior extremity of the carapace is equally so; the posterior portion of the latter slightly, if at all; whilst the abdominal segments are as devoid of calcific matter as any crab that has just cast its shell. We are thus enabled to ascertain, without difficulty, the relations between the superficial layers and the subjacent derm or endoderm of Huxley. The careful study of this species has satisfied me that *a well-marked* basement membrane interposes at all stages of development, between the cellular endoderm or derm and the tubulated layers, whether calcified or uncalcified; and that consequently the cells of the endoderm cannot enter histologically into the outer tegumentary layers forming the crustacean shell.

The true derm or endoderm of Huxley, in the hermit lobster, is thick and full of nuclei, colourless cells, and red, blue, and brown pigment-cells. A section of the entire integument of the soft carapace is represented in fig. 17, where *g* indicates the derm, *h* its cells and nuclei, *i* its pigment-cells, *k* the basement membrane, *b* the corium and areolar layers blended, and *a* the pellicular layer. The pigment-cells are sometimes stellate, at others appear as rounded granular bodies. Fibrous threads often interlace amongst the cellular elements. The basement membrane is a thin tissue of the most delicate character. The appearance represented on looking vertically through this membrane at the subjacent derm is delineated in fig. 18, where the letters indicate the same parts as in fig. 17. The uppermost cells of the derm (18 *h*) are larger, more turgid, and more regularly distributed in the deeper parts of the tissue, reminding us of the aspect of cartilage-cells in growing bone near the line of ossification. Immediately above the basement membrane is seen a layer of membrane (fig. 17 *b*) with a granulated texture. In the wholly uncalcified parts of the integument this membrane is scarcely visible; but it becomes more so as we approach the head, where it presents a faintly areolated structure, like that seen in the shrimp, whilst numerous patches occur in which the areola-

tion is very distinct, especially in the anterior parts of the carapace. This tissue obviously represents both the areolar layer and the corium of fig. 16. In some parts of the tail, where I have been unable to detect this tissue, its place is occupied by a structureless pellicle apparently identical with that represented in fig. 16 *a*: since I have distinctly traced its extension *over* the granular layer where the latter exists. On tearing a semi-calcified portion of the carapace in which the areolæ were but faintly discernible, the torn margin appeared defined and angulated, corresponding with the inter-areolar lines, proving the latter to be lines of less perfect cohesion than the rest of the tissue. On decalcifying the fragment thus torn the areolæ almost entirely disappeared, demonstrating how much they owed to conditions of calcification.

The above example appears to throw direct light on the genesis of crustacean integuments. It is clear that no cells exist external to the basement membrane; they all underlie it. Whether or not the basement membrane is cast off along with the exuviated shell has not yet been determined, but probably such is not the case. The cellular derm appears to be the secreting organ, producing the tegument, which latter permeates the basement membrane by exosmosis, when in a fluid state, and becomes consolidated into a structureless layer external to the membrane. The laminæ first formed are apparently those constituting the pellicle, then those constituting the areolar layer, and subsequently those forming the corium. Calcification of these layers, both in its primary and secondary varieties, is a process occurring subsequently to the formation of the membranous lamellæ, and probably due to some protoplasmic fluid conveyed into the tissues by means of the tubuli with which they abound. Prior to the formation of these laminæ some of the cells of the derm or enderon change their form and position. The tubuli themselves probably exist as such *prior* to calcification; the latter only rendering them more distinct.

The process of calcification appears to be identical with what I have elsewhere shown to occur in the genesis of the tooth of the Echinus ('Journal of Dental Science') and in the scales and bones of fishes ('Phil. Trans.') Commencing as a granular point, each calcareous atom increases by concentric additions to its exterior, leading to cohesion of separate particles, and consolidation of the entire tissue. As no cells are traceable in the chitinous layers of membrane, the formation of these granules, it must be admitted, goes on independently of any direct cellular agency.

The laminated structure of these calcareous concretions is beautifully shown by some examples I met with in a very small Australian crab. The fleshy substances in the claws were dried up, but in their interior were numerous botryoidal concretionary masses, the structure of which, as revealed in thin sections, is represented in fig. 19. The concentric lamination is here so obvious, that no question can arise as to the mode of increment, whilst the masses appear manifestly to be but enlarged illustrations of what we found on a smaller scale in figs. 7, 8, 9, 10, and 15. Numerous dark points existed in these concretions, as represented in the lower part of the figure, but which are omitted in the upper part, in order to display the completeness of the concentric lamination.

We are thus compelled, equally from an examination of their mature states, and from their development as traced in the hermit crab, to reject Dr. Carpenter's hypothesis of the cellular structure of the areolated layers of crustacean integuments. At the same time, they illustrate how a cellular protoplasmic structure may secrete a tubulated tissue, closely resembling dentine, from which it is separated by a structureless basement membrane, through which neither cells nor nuclei ever pass. Whether the cells represented in fig. 18 have anything to do with determining the position of the areolæ in the calcified layers I cannot say, though I doubt their doing even that much, since the spaces they occupy do not seem to correspond with those of the areolæ; nevertheless, the question is worth further investigation, could Crustacea, that have just moulted be obtained for examination.

On the Measurement *of the* Striæ *of* Diatoms.

By J. D. Sollitt, Esq., Hull.

A paper having appeared in the 'American Journal of Science' for March, 1859, by W. S. Sullivant and T. G. Wormley, on the "Measurement of the Striæ of Diatoms," I think it necessary to make a few remarks on their observations, in order to endeavour to prevent the spread of far greater errors on this interesting point than those which they consider they have corrected. As the subject now stands, it is very similar to the men with the chameleon; and had Messrs. Sullivant and Wormley, before publishing their paper, made themselves better acquainted with all the variations in the markings on the Diatomaceæ, they would have come to a different conclusion to what they have done. To show that this is the fact, I will first call attention to the *Pleurosigma fasciola*. Of this diatom the kind we find near Hull are very small, and consequently the markings extremely fine, the finest being, as I have before stated, 90 in the $\frac{1}{1000}$th of an inch; but the Fasciola we get from Boston, in Lincolnshire, are many of them so large that there are not more than 50 striæ in the $\frac{1}{1000}$th of an inch. I have frequently seen the longitudinal and cross striæ at the same time on the largest-sized Fasciola, from Boston, with the half-inch objective, either of Ross or of Powell and Lealand; but the finest we find at Hull will defy even Powell's one-sixteenth, with 175° of angle of aperture, to show the same, use what illumination you may. The length of the finest Hull Fasciola is under $\frac{1}{300}$th of an inch, whilst some of the Boston Fasciola measure more than $\frac{1}{180}$th of an inch in length. Again, in the *P. strigosum*, I may observe that those from the coast of Sussex have their markings very strong, even stronger than set down by Messrs. Sullivant and Wormley; but those we find at Hull, and which were first named Strigosum by Mr. Harrison, in 1846, have exceedingly fine markings on them, varying from 72 in the $\frac{1}{1000}$th of an inch up to nearly 80. With regard to the striæ on the *Nitzschia sigmoidea*, we have another very striking instance of how little we know respecting the markings on the Diatomaceæ. I have one slide of this diatom, on some of which the markings are very strong and easily seen, whilst others, in the same slide, set at defiance every method of illumination to

bring them out, and I have little hesitation in stating that the striæ on this diatom vary from 65 in the $\frac{1}{10000}$th of an inch up to a degree of fineness which no lenses that we now have will show. I have always found the various kinds of Nitzschia to be the most irregular in the number of their striæ in the inch, of any Diatomaceæ that I have studied.

The *Navicula rhomboides* is another instance of the impossibility to give correct measures of the number of striæ on any diatom. Our American friends have set the number down at 70 in the $\frac{1}{10000}$th of an inch, Smith says 85. I have one or two specimens of this diatom that have not more than 60 in the $\frac{1}{10000}$. I have others, again, so fine as to defy all means of showing the striæ on them, and those all in the same slide and of the same gathering. I could, if necessary, apply similar observations to all the different diatoms of which our American friends have given us the measurement. Had they been acquainted with those facts, I think they would never have published what they evidently consider their standard of correctness, nor would they have tried to prove that all other observers except themselves were in error.

Nothing leads to such great mistakes in scientific inquiry as too hasty conclusions. I consider that all their measures are correct, as far as they have gone. They have played the *air* very well, but they have neglected the *variations*.

I may further observe that our American friends are not to come to the conclusion that all the measures given in Smith's "Synopsis" are his own, as I know for a fact that many of them were communicated to him by others. He was a most indefatigable observer; but one man cannot do everything, and the great wonder is the correctness of most of the measures which he has given for diatoms of a medium size.

I now come to Messrs. Sullivant and Wormley's remarks on the *Amphipleura pellucida*. They say, "We have not been able even to 'glimpse' the striæ on this diatom. Messrs. Harrison and Sollitt, in their paper above cited, estimate the striæ at 125 to 130 in the $\frac{1}{10000}$th of an inch." They further add: "In conclusion, we may remark that our experiments are confirmatory of the generally received opinion that striæ closer than about 85 in the $\frac{1}{10000}$ have not yet been resolved." In their measurement of those diatoms the striæ of which they have been able to see, I have no doubt of their general correctness; but their remarks on the *A. pellucida* put me in mind of the fine double star, η *Coronæ*,

first seen double by Dr. Herschel, and on which a writer makes the following remark: "Many a star-gazer has bravely turned out on a bitter cold night and stared at *η Coronæ* until every particle of his patience and caloric have been fairly frozen out, and his eyes cried for mercy, without ever being able to 'glimpse' this delicate object; and then he comes to the conclusion that those who said they had seen it double had never done so."

Under the circumstances in which I am placed by the uncalled-for remarks of our American friends, it will be necessary for me to show that the striæ on *A. pellucida* have not only been seen by myself and many others, but by showing this to prove that their conclusion respecting the impossibility of seeing striæ closer than 85 in the $\frac{1}{1000}$ is incorrect.

Many parties in this country have been under the same false impression with respect to the visibility of those very close striæ, but all that I have met with, and to whom I have shown the striæ on the *A. pellucida*, have, after seeing them, altered their opinion.

The clever microscopist, Mr. E. J. Lobb, of 148, Cheapside, thus writes to me: "Mr. Ross, Mr. Hewitt, Mr. Roper, Mr. Powell, Mr. Lealand, and many others, have all seen the striæ on the *Amphi. pellucida* clearly defined by me at my house. Mr. Ross told me he came a sceptic, but went away convinced." My friend, Dr. Munroe, of Hull, can also bring out the striæ on this diatom very clearly, and he has shown them to a great many very first-rate microscopists, and whom he has also instructed in the proper method of manipulation for showing them. Mr. Harrison has likewise done the same thing with many others.

If what I have here stated be not sufficient to convince our American friends that the striæ on the *A. pellucida* can be seen, then the only thing I can suggest is for them just to take a trip across the Atlantic, when we shall have much pleasure, not only in showing them the striæ on this diatom, but also in giving them such instructions in manipulation as to enable them for the future to see the same things in America that we can see in England, and I think, also, to convince them that if the striæ, the distance of which is 85 in the $\frac{1}{1000}$, can be seen; with proper means, those which are only at half that distance can be seen also. In conclusion, I send you some of my most recent measures of the distance of the striæ on a few of the better known Diatomaceæ in $\frac{1}{1000}$th parts of an inch.

P. strigilis	30	.	.	cross striæ.
„ formosum	32	down to	20	oblique do.
„ Balticum	40	„	20	cross do.
„ quadratum	60	„	35	oblique do.
„ hippocampus	45	„	40	cross do.
„ attenuatum	46	„	35	ditto.
„ Spencerii	50	genuine specimen from the late J. W. Bailey.		
„ strigosum	80	down to	40	oblique striæ.
„ angulatum	51	„	46	ditto.
„ fasciola	90	„	50	cross do.
N. rhomboides	111	„	60	ditto.
A. pellucida	130	„	120	ditto.

My friend Mr. Lobb is of opinion that the estimate of the striæ on the last of those diatoms is even too low, as he thinks they ought to be set down at 140 in the $\frac{1}{1000}$th of an inch. From all the above remarks I should like to know what we are to call authenticated specimens. And I think the only conclusion we can come to is, that there is here a very wide field for future observation. The above differences in measurements of the various diatoms do not make them the less valuable as test objects for microscopes, but when used as such, the observer ought always to know what he is looking at.

TRANSLATIONS.

On the Distinguishing *of* Elevations *and* Depressions *under the* Microscope. By Dr. H. Welcker.

('Zeitsch. f. ration. Medicin,' 3 ser., Bd. vii, p. 63, 1859.

It cannot be contested that the most important point in every microscopical investigation is the correct interpretation of the visible image presented to us. But, as in the latest classical work by Dr. Harting ('Das Microskop,' &c.) the subject of Microscopic Diagnosis does not appear to me to have been treated so fully or so correctly as it might have been, I venture to recur to the subject, which has already been noticed by me in papers on Microscopic Technology formerly published in this Journal.*

I. *On Diagnosis by oblique illumination.*

Dr. Harting considers that minute elevations and depressions on microscopic objects may be readily confounded, owing to the circumstance that each is indicated under both transmitted and direct light by a shadow (Schlagschatten), which may be exactly alike in either case; but whose position as regards the source of illumination does not in microscopic vision immediately indicate the true form of the object, as it does in ordinary vision,—for the reason, that the requisite point of comparison is, in the former case, more or less wanting. But in the *compound microscope* a deception may more readily arise "because the whole image here appears inverted, and the shadows consequently fall in a direction opposite to the true one;—that is to say, in the case of an elevation they are directed towards the source of light, and the reverse in case of a depression."

* 'Zeits. f. rat. Med.,' 2 ser., vi, p. 172, and viii, p. 241.

In opposition to this, I would remark: *that in transmitted light there are no shadows* (Schlagschatten) *at all,* and in direct illumination only when the light falls upon an opaque object. If an opaque object having vertical elevations on its surface be viewed under the simple microscope by direct light every elevation will exhibit a shadow on the side which is turned from the light. But if a transparent object, that is to say an object which acts as a lens—as for instance, a starch granule lying on a black surface—be viewed with a lens by direct light, the less illuminated side of the granule, but which is obviously not in shade, will be that which looks towards the light, whilst on the opposite side will be exhibited its *focus*. That this distribution of the *bright* and *dark*, due to the lenticular nature of the object, is, it must be confessed, deceptively similar to the *light* and *shade* of ordinary illumination, I have already (loc. cit.) remarked.

In cases where, by transmitted light, a visible *shadow* is exhibited, this is always consequent upon *oblique illumination* (whether produced by a lateral position of the mirror or of the diaphragm, or in any other way, is immaterial), and it is only to such cases that Harting's statements above quoted can refer, although in the section in which they occur the expression "oblique illumination" is not employed.* But when Harting says that the shadows of an elevated object, owing to the reversal of the image in the compound microscope, fall on the side *looking towards* the light—it is obvious enough that that is the side on which a "shadow" must be placed. *But the phenomenon is not so at all,* for we find that the supposed shadows of elevated objects viewed in the compound microscope are situated on the side which looks from the mirror.

The supposed "shadow" of convex transparent objects, as I again repeat, is not a shade at all, but it is the less illuminated portion of a body which acts like a convex lens. In the simple microscope we perceive the focus which is turned to one side by the oblique illumination, on the side looking from the mirror, and in the compound microscope on that which looks towards it.

II. *Diagnosis by movement of the tube.*

For the distinguishing of elevations and depressions

* In § 201 it is expressly stated that oblique transmitted light acts in exactly the same way as does the oblique position of the object, that is to say, by the *production* of *shadows*.

Harting (§ 885) further recommends the "*changing of the distance of the object,*" which in most cases suffices, unless the elevation or depression be altogether inconsiderable. But it is precisely in the latter case, in which according to Harting the movement of the tube leaves us in the lurch, often that the determination appears to be most important and desirable. In this case, it may be necessary, according to the same author, "to view the object in a direction perpendicular to that in which it was first placed;" and he cites the acetabular depression of the blood-corpuscles, and the hollows on lignified vegetable cells, as instances in which this kind of profile view affords the wished-for result. But how often is it not altogether impossible so to place certain small objects in such a position, or to procure such a section of them, as would exhibit the elevation or depression in question, in profile? In these cases, however, I would suggest as a means of diagnosis the *elevation and depression of the tube*, inasmuch as I have proved that the most minute punctiform elevations and depressions, *whilst acting as convex and concave lenses*, exhibit different optical characters. The course of the rays of light through spherical objects, some of which act like convex and others as dispersive lenses, is ably discussed by Harting (§ 275) and illustrated by figures; but I do not find that he has either confirmed or contradicted my statement, that all extremely minute convex and depressed objects, as representatives of which I adduced the dry spermatozoid and the lines on a micrometer, appear black or light according to the position of the tube (the convex appearing light on the elevation and the depressed on the depression of the tube), and that this phenomenon is referrible to the lenticular property of the objects, and affords a certain, frequently the only means by which to judge of their figure.

This is not the place again to point out the various precautions to be observed in the employment of this method, for which I must refer to my former communications.

In conclusion, I give a tabular summary of the various possible modes in which the *light* and *dark* may be disposed in objects illuminated obliquely.

I. *Observation by direct light.*

Object.	*Simple Microscope.*	*Compound Microscope.*
(*a*) Convex, opaque; *e.g.* opaque, erect papillæ	*Shadow* on the side turned from the light	*Shadow* on the side turned towards the light.
(*b*) Convex, transparent; *e.g.* a starch-granule	Dark on the side turned towards the light	Dark on the side turned from the light.
(*c*) Hollow on an opaque object	*Shadow* on the side turned towards the light	*Shadow* on the side turned from the light.
(*d*) Hollow on a transparent object	Dark on the side turned from the light	Dark on the side turned towards the light.

II. *Observation by transmitted light.*

Object.	*Simple Microscope.*	*Compound Microscope.*
(*a*) Convex, transparent.	Dark on the side turned towards the light	Dark on the side turned from the light.
(*b*) Depressed, transparent.	Dark on the side turned from the light	Dark on the side turned towards the light.

REVIEW.

The Nature-printed British Sea-Weeds; a history accompanied by figures and dissections of the Algæ of the British Isles. By WILLIAM GROSART JOHNSTONE, F.B.S.E., and ALEXANDER CROALL, A.B.S.E. Nature-printed by HENRY BRADBURY. Vol. I. Rhodospermeæ, Fam. I—IX. London: Bradbury and Evans.

THE success of the production of the British ferns by the new process of nature-printing has encouraged Mr. Bradbury to attempt a much larger family of plants. The sea-weeds, on account of their membranous nature, presented peculiar facilities for representing them by nature-printing; and in this volume we have an instalment of a work which is to be devoted to the whole of the British species of this family.

The process of nature-printing, which has the power of reproducing with great accuracy the outline and impressions on the surface of plants, is effected by a kind of modelling. The plant is first impressed upon a sheet of soft metal, and from this a copper impression is taken by means of the electrotype process. Into these copper plates the paper on which the plants are produced is pressed, the plate having been previously prepared with colour according to the colour of the plant. This process, which is so well adapted to secure the natural outline and superficial markings of plants, cannot to any extent be employed in the reproduction of minute points of structure, especially where this involves anything more than can be obtained from a surface impression. Under these circumstances, the authors in this work have added to each plate drawings of the structure and microscopic characters of the fruit of the various species of algæ represented in the plates. It is this part of the work that will be found more espccially interesting to the microscopic observer. Every species of sea-weed has its

own peculiar power of reproductive organs, and few objects are more beautiful and more interesting subjects of microscopic research at the seaside than these organs amongst the algæ.

The present volume is only one of four which it is intended to devote to the whole of the British Algæ. It contains sixty-six plates, and embraces only a part of the *Rhodospermeæ*, the remainder of which will appear in the second volume. The families illustrated in this volume are *Rhodomelaceæ, Lamenariaceæ, Corallinaceæ, Sphærococcoideæ, Gelidiaceæ, Spongiocarpeæ, Squamarieæ, Helminthocladieæ, Wrangeliaceæ*. These families are embraced under the division Desmiospermeæ, a group in which the spore-bearing nucleus consists of tufted spore-threads attached to a cellular placenta. The spores are formed singly, one in each cell of the spore-thread, or only one in a terminal cell.

Many of the species illustrated in this volume are amongst the most elegant and fragile of the algæ. We can, however, from a comparison of them with recent specimens at the sea-side, speak of them as exceedingly accurate in their forms, and very close to nature in their colours. There is one group, however, which seems to have defied the nature-printing process, and that is certain forms of the Corallinaceæ. These plants creep along over stones and rocks, something in the same way as lichens; and as they cannot be removed without damage from the objects on which they grow, of course nothing was left but to give coloured drawings or engravings of them. This has been done with the genus *Meloseira*, embracing the various forms of crustaceous algæ known by the name of Nullipores. These plants, which were at one time regarded as zoophytes, and even described by the late Dr. Johnstone with sponges, have a great interest for the physiologist, as indicative of the earliest struggle of organic forces with the chemical laws of nature. They still present an interesting subject for study, although their vegetable nature has been well made out, and the arrangement of their reproductive tissues is found to resemble closely many of the higher forms of the red sea-weeds (*Rhodospermeæ*).

Although this work is evidently intended for the botanical student already acquainted with the details of the structure of the algæ, we think it might be made a more widely interesting work if it were accompanied by an introduction to the study of the structure and functions of the algæ. We know that a good introduction already exists in Mr. Berkeley's admirable Introduction to the study of Cryptogamic Botany. But this work embraces other things, and has been published

now several years, and we should be glad to find the authors of the present volume undertaking such an introduction—a work for which they are evidently most competent.

The work is very properly dedicated to the memory of the late Mrs. Griffiths, of Torquay. She was not only a brilliant example of what her sex may do for the advancement of science, but her many discoveries of species, and devotion to scientific pursuits, entitle her to the gratitude and respect of all who are interested in the progress of natural history studies.

The description of the plants which accompany the plates appear to us to be drawn up with care. Of course, extensive use has been made of the works of Dr. Harvey, of Dublin, to whom algology is so largely indebted. The authors seem, however, to have had extensive communication with those best acquainted with British algæ, and their references to habitats are extensive. The synonymy is also carefully given, and references made to the works of authors who have written on the subject of algology. We have great pleasure in strongly recommending this work to the attention of all who are interested in the study of the vegetation of the seas of Great Britain.

NOTES AND CORRESPONDENCE.

Cristatella Mucedo.—Where to look for and how to find this Polyzoon.—Having lately (July 6th) obtained a number of specimens of this beautiful Polyzoon, after very many ineffectual but most diligent searches, in a large canal reservoir, where I had frequently found the characteristic statoblasts in the greatest profusion, I beg to offer a few suggestions in the hopes of enabling all those who love a microscopic treat, to hunt successfully for this exquisite treasure.

Where to look? then, is the first question. "In clear ponds and lakes," as Professor Allman tells us. The localities in which I have found either the mature animal or the statoblasts are the following:—1. A mill-pond on the Elmdon road, belonging to Mr. Allston, about two miles from Solihull. 2. A large canal-reservoir on the Warwick and Birmingham road. 3. A pool of water in the grounds of the Earl of Shrewsbury, at Alton Towers. I was rather surprised to find the statoblasts here, inasmuch as the water is decidedly somewhat muddy. Now, I am inclined to believe that Cristatella is as frequently to be met with as many other of the fresh-water Polyzoa—Alcyonella, Fredericella, and some of the Plumatellidæ, for instance; but while in these cases an upturned stone, or the under side of a submerged branch or leaf, at once reveals the presence of the adherent Polyzoa—for the sponge-like masses of *Alcyonella*, and the interlacing or branching tubes of the Plumatellidæ, are evident to the eye, without the slightest effort; it is not by any means so easy a matter to detect the presence of Cristatella, whose light-yellow cœnœcium can only with much difficulty and continued straining of the eyes be seen, as the little colony rests upon some submerged weed or stone, which weeds at this time of the year are sure to be overspread with scum, Diatomaceæ, and the faded filaments of some Algæ, of the same colour as the animal.

Every lake, then, or mill-pond, or reservoir of clear water, may be suspected to contain these most exquisite of all the Polyzoa; and as the statoblasts are more easily found than the developed colony, I would advise the searcher to look for them in the autumn and winter and spring, as he

will then have the satisfaction of knowing that there do exist, in the pond he is searching in the summer, the mature animals themselves. In order to obtain statoblasts, I would say, look out for the sheltered spots in the pool, where are collected all the floating rubbish, tangled masses of Algæ, decayed roots of grasses, feathers of birds, &c., &c. (it is a curious fact that I have almost always found a quantity of Cristatella statoblasts attached to feathers; so that I had only to find these, and I was nearly sure to be rewarded with a number of these little round membranous cases agglomerated in one mass). Carefully examine the rubbish bit by bit; in your hands if you like; but the best way is to separate and thin out the rubbish in the water, when the statoblasts will readily show themselves as dull masses, sometimes nearly an inch long. The isolated individuals are not to be depended upon as a rule, if you wish to watch the germination; for they are generally only the separated faces of old specimens. I have taken home frozen-up lumps of rubbish, and have from these obtained statoblasts which have duly germinated, though I have never been able to keep the young polypes alive more than a few weeks.

But if the fully developed colony is the object of your search, then in the months of July and August, and even in June if the weather has been warm, visit the pond wherein the previously discovered statoblasts had shown evidence your matured treasure would be, and be not content with merely stooping down, and pulling out the weeds of *Ranunculus aquatilis* and the Potamogetons, and examining them in your hands out of the water, for such a search will most probably prove an ineffectual one—it being almost impossible, amid the confervoid growth which covers the plants, to detect the collapsed form of your much-prized Cristatella; but you had better lie flat down at once on the edge of the bank (the Polyzoa are almost always within a few feet of the bank, covered by water varying from an inch in depth to about two feet), flat down *in ventrem*, with your eyes close to the surface of the water—then, with as little disturbance of the water as possible, gently with your hand clear away the floating weeds, and examine every submerged plant *in situ*, just as it grows in the water, with much patience. Probably, for a minute or two, you will see nothing like a Cristatella; but be patient, continue to gaze, and you will be rewarded most likely by observing, amid the scum and confervæ, an oblong-shaped feathery object, about an inch long perhaps, of a pale-yellow colour, bearing a strong resemblance to the well-known gelatinous egg nidamenta of *Limneus stagnalis*

—only this is transparent, while Cristatella is, as I said, feathery-looking, like, as M. Gervais has observed, bits of Chenille—it is impossible, I think, to find a more apt similitude. And now that you have once seen one specimen, you will have little difficulty in being able to discover any amount of others.

The extreme beauty of this Polyzoon, the fact of its continuing in an exserted state, even under rough treatment, the transparency of the cœnœcium rendering an anatomical examination so easy and satisfactory, must always make Cristatella a great favorite, and one of the most prized and beautiful of all the beautiful forms of aquatic life.—HOUGHTON.

Angle of Aperture. — Observing in the 'Microscopical Journal' of July last, an article on the measurement of angular aperture of lenses from the pen of P. Gray, Esq., and deeming its recommendations based upon determining these observations irrespective of any special apparatus, thus seemingly presenting facilities to individuals who may neither have such in possession, or ready access thereto, I have examined the practical merits of the method in question, in contrast with the known angular aperture of lenses in my possession determined by other means, as No. 1 = 25°; No. 2 = 63°; No. 3 = 91°; No. 4 = 129°; the following results being obtained, exercising all ordinary care.

No. 1.

		Decimal Number.	*Logarithm.*	*Tangent.*
Lights apart	7 inches			
Distance of lens	$16{\cdot}75 \times 2$	·2089	= 319938 or	11·49
				×2
			Angle of aperture	23·38
			Another experiment gave	26·14

No. 2.

		Decimal Number.	*Logarithm.*	*Tangent.*
Lights apart	15·50 inches			
Distance of lens	23	= ·6739	= 828595 or	33·58
				×2
			Angle of aperture	67·56

The results by this lens were very variable, though not so by the usual several feet radius.

No. 3.

		Decimal Number.	*Logarithm.*	*Tangent.*
Lights apart	30·5 inches			
Distance of lens	$14\frac{1}{4} \times 2$	= ·9506	= 977998 or	43·33
				2
			Angle of aperture	87·06

Two other experiments gave similar results; one gave 90°.

No. 4.

The rule presented gave no provision for angles exceeding 90°; wherefore the supplement of the bi-tangent is used through previous knowledge of that required.

	Decimal No.	*Logarithm.*	*Tangent.*
Lights apart $\frac{44 \text{ inches}}{10 \times 2}$	= ·4545	= 657534	or 24·26
			×2
		Rule ends =	48·52
			180—
		Angle of aperture	131·08 supplement.
		Another experiment gave	131·06
		Ditto ditto	126·24

Howsoever in theory the proposed plan may be, I am satisfied that even with common care the results in practice must prove very variable, and amounting, in some instances, to differences of four or five degrees; thus not gaining much upon the quantities ordinarily published by the makers of objectives.—WILLIAM HENDRY, Surgeon, Hull.

Diatom-Finder.—I have had a simple little instrument made for me by Messrs. Field and Co., that answers my fullest expectation as a diatom-finder. It consists of the tube of their Arts Society's microscope, six inches in length, with the higher eye-piece fitting into one end, and an object-glass giving 180 and 130 diameters, into the other (the screw also takes Powell and Lealand's object-glasses). This compound body slides into another tube about two inches short, and is checked by a flange from going too far. On the end of this second tube is cemented a thin disc of glass, and over it fits a cap with a thicker disc, forming an ordinary animalcule-cage. When used you remove the cap, place a drop of the fluid to be examined on the end of the tube, replace the cap so as to flatten out the drop, and hold the body up to the light, adjusting the focus. The contents of the drop by their own gravity may be made to cross and recross the field, simply by moving the body in the hand. The whole fits into a little telescope-case an inch in diameter. —ROBERT TAYLOR.

PROCEEDINGS OF SOCIETIES.

June 29th, 1859.

Dr. LANKESTER, President, in the chair.

Henry Judd, Esq., Alfred Canton, Esq., Dr. Prendergast, Henry Yool, Esq., H. A. Silver, Esq., E. C. Anderson, Esq., and the Duke of Manchester were balloted for, and duly elected members of the Society.

A paper "On a Section and a Mounting Instrument," by Mr. James Smith, was read (p. 1).

A paper by G. F. Pollock, Esq., "On Granulated Blood-discs," was read (p. 4).

The meetings of the Society were then adjourned until October next.

The following publications, &c., have been presented to the Microscopical Society since the publication of the last Journal.

March 31st, 1859.

	Presented by
Observations on the Genus Unio. By Isaac Lea	The Author.
Description of Twenty-seven New Species of Uniones. By Isaac Lea	Ditto.
Journal of the Geological Society, Vol. XV, Part 1	The Society.
Address of the President of the Geological Society, Major-General Portlock	Ditto.
Linnean Society. Supplement to Botany, No. 1	Ditto.
Proceedings of the Academy of Natural Sciences of Philadelphia. Several Parts	Ditto.

April.—No Meeting.

May 25th.

Musci Alleghanienses sive Spicilegiæ Muscorum atque Hepaticarum quos in itinere a Marylandia usque ad Georgiam. By W. S. Sullivant. 2 vols. 1845	The Author.
The Mosses of the United States. By W. S. Sullivant. 1856	Ditto.
Contributions to the Bryology and Hepaticology of North America. Two Parts. 1849. By W. S. Sullivant	Ditto.
Report on the Botany of the Expedition for a Rail-road Route from the Mississippi River to the Pacific Ocean. By W. S. Sullivant. 1856	Ditto.
Notices of some New Species of Mosses from the Pacific Islands. By W. S. Sullivant. 1856	Ditto.
Musci Boreali Americani quorum specimina exsiccata. By W. S. Sullivant et L. Lesquereux. 1856	The Authors.

	Presented by
On the Measurement of the Striæ of Diatoms. By W. S. Sullivant and T. G. Wormley. Also Twenty-four Slides of Diatoms with the above . .	The Authors.
The Proceedings of the Academy of Natural Sciences of Philadelphia. 1857 . . .	The Society.
The Ohio Agric. Report. 1856 . .	Ditto.
June 29th.	
Quarterly Journal of the Geological Society, Vol. II, Part 2	Ditto.
The Journal of the Royal Dublin Society, Nos. 12, 13	Ditto.
The Photographic Journal, No. 85 . . .	Ditto.
The List of the Linnean Society. 1858 . .	Ditto.
Journal of the Proceedings of the Linnean Society. Supplement to Botany, No. 2 . .	Ditto.
Journal of the Proceedings of the Linnean Society, Vol. III, No. 12	Ditto.
Transactions of the Linnean Society, Vol. XXII, Part 3	Ditto.
Nine Photographs of various Microscopic Objects. By M. S. Legg, Esq. . . .	M. S. Legg, Esq.
June to *October*.	
Thoughts on Animalcules; or, a Glimpse of the Invisible World revealed by the Microscope. By G. A. Mantell. 1846 . . .	F. C. S. Roper, Esq.
Das Mikroskop. Von P. Harting. 1859 .	Ditto.
Some Observations on the Diatomaceæ of the Thames. By F. C. S. Roper. 1854 . . .	The Author.
Notes on some New Species and Varieties of British Marine Diatomaceæ. By F. C. S. Roper. 1857 .	Ditto.
On the Genus Biddulphia and its Affinities. By F. C. S. Roper. 1858	Ditto.

The following have been taken in exchange for sets of the original Transactions and back numbers of the Journal.

EXCHANGES.

Construction of Timber from its earliest Growths, explained by the Microscope. By J. M. D. Hill. 1724.

Dr. Hassall's British Fresh-water Algæ, 2 vols. 1845.

Kölliker's Manual of Human Histology, 2 vols. Sydenham Society, 1852-54.

Wedl's Pathological Histology. Sydenham Society. 1854-55.

Recherches Chimiques et Microscopiques sur les Conferves, Bisses, Tremelles, &c. Par Girod-Chantrans. 1802.

Cours de Microscopie complémentaire des études médicales Anatomie microscopique et Physiologie des Fluides de l'economie. Par Al. Donné. 1844.

Traité anatomique de la Chenille. Par P. Lyonet. 1762.

Species Algarum. Par F. T. Kützing. 1849.

PURCHASES.

A Handbook of the Microscope. By W. L Notcutt. 1859.

Dr. Pereira's Lectures on Polarised Light. 1854.

The Microscope. By Dr. Lardner. 1856.

Professor Quekett's Lectures on Histology. 1854.

ORIGINAL COMMUNICATIONS.

Observations *on the* Structure *of* Nerve-Fibre.

By J. Lockhart Clark, Esq., F.R.S.

Whenever we wish to ascertain the *natural* appearance and *structure* of the *nerve-cells* and nerve-fibres, these tissues should be examined in some transparent part during life, or on removal immediately after death, and with the addition only of a little serum of the blood. But when it is intended to investigate, in the nervous centres of the vertebrata, the mutual relation of these elementary parts, and their natural arrangement, such as the grouping of the cells and the course of the fibres, it becomes necessary to harden the nerve-substance in some kind of fluid, so that it may be cut into thin sections, which can then be rendered more transparent by a further process. The method which I extensively employ for such investigations is as follows:

The part intended for examination should be as fresh as possible, and cut into pieces as small as compatible with the particular end in view. These pieces I formerly hardened by means of a mixture of one part of spirit of wine and three parts of water, which, at the end of twenty-four hours, was replaced by a fresh mixture of equal parts of spirit and water, and this again, after the same interval, by pure spirit, which ought to be renewed every five or six days. But for the last three years I have used chromic acid instead of spirit, in the process of hardening. The spinal cord of man, of the Ox, Sheep, and other large vertebrata, is steeped in a solution of one part of crystallized *chromic acid* in two hundred parts of water, for two or three weeks, and then placed in a solution of one part of *bichromate of potash* in one or two hundred parts of water. For the hemispheres and the

cerebrum and cerebellum, and for the spinal cord of Rodentia, Reptiles, and Fishes, the solution must be three or four times weaker. Spirit is used to wet the knife in making the sections, which are placed in spirit for a few minutes, and then, if thin, floated on the surface of spirit of turpentine. Here they remain until they are quite or nearly transparent, when they are removed to glass slides, on which a little Canada balsam has been previously dropped. If now examined under the microscope, they frequently show but little traces of cells or fibres; but if they be set aside for a time, and treated occasionally with a little turpentine and Canada balsam, the cells and fibres will reappear, and present a very beautiful appearance. Before they are finally covered with thin glass, they should be examined at intervals under moderately high powers. If the sections be thick, I find it best to place them in a shallow vessel simply wet with turpentine, which can therefore *ascend* from below, while the alcohol *evaporates* from the *upper* surface; for the *principle* of the method is this,—to *replace* the *spirit* by *turpentine*, and *this* by *Canada balsam*, without *drying* the sections. The method at first presents some difficulties, and practice is necessary for complete success; but when properly conducted, it affords many great advantages, which no other method that I am acquainted with can supply.* Not that I wish to imply that this, unlike every other method, is in *every* respect *perfect*; nor do I always confine myself exclusively to its use; for whenever I find that chromic acid, alone, offers greater advantages on any particular point, I avail myself of it; as I do of any other means that appear most suitable for the occasion. Sometimes I find it useful to colour the sections, according to Gerlach's plan, before they undergo the process already described, but I think it rather interferes with sharpness of the fibres. The sections should be washed free from the spirit employed in cutting them, and then immersed for a few hours in an ammoniated solution of carmine of a deep rose-colour, and previously filtered through paper; for, without these precautions, a deposit or crust is apt to form on the object, in consequence of the precipitation of the carmine; and for the same reason the section, on being removed from the carmine, should be again washed in water before being placed in spirit, and then in turpentine.

Such were the carmine-coloured preparations which Messrs.

* This method of rendering sections transparent has been adopted in Austria by Lenhossék (with some slight modification); by Gerlach, in Germany; and quite recently, by Schroeder van der Kolk, in Holland.

Lister and Turner inspected, and made the subject of comment in the last number of this journal. It is true, that in the transverse sections the spiral arrangement around the axis-cylinders is frequently, but not always, very faint, in consequence, I think, of the *aqueous* solution of carmine in which they are immersed, and which probably allows the turpentine to have a greater influence on the *white* substance; for in the *un*-coloured preparations, when properly made, the spirals, or concentric circles, are most distinctly marked, and their outlines, as well as the intervening connective tissue, are more sharply defined than in any sections of the medulla simply hardened in chromic acid. Preparations of this kind are in the possession of several eminent physiologists, amongst whom I may mention Professor Hughes Bennett, of Edinburgh; so that Messrs. Lister and Turner will have the opportunity of inspecting them. While the white substance of Schwann, however, is thus distinctly observable in transverse sections, it is often but faintly seen, and sometimes invisible, in longitudinal sections, unless the medulla be hardened in a peculiar way, by first using a *weak*, and then a very *strong* solution of chromic acid. But even the total loss of this substance would be of little or no importance in tracing the *course* of the fibres and their relation to other tissues, for their axis-cylinders are rendered more than naturally conspicuous and strong; while their sharpness of outline, the fine definition of the other tissues under high powers, and the advantage of examining them in sections of amazing thickness, fully compensate for a loss which may easily be supplied, when necessary, by some other mode of preparation. But, as already stated, whenever we wish to ascertain the natural appearance and structure of the nerve-tissues, we must abstain from all kind of preparation. Before I proceed further, however, I will briefly explain the doctrines of Stilling on the structure of nerve-fibre.

In 1855, Stilling announced to the Academy of Sciences of Paris, as the results of his inquiries, that the whole of the primitive nerve-fibre—the membranous sheath, the white substance of Schwann, and the axis-cylinder—are composed of a continuous network of similar "elementary tubules."*

* 'Comptes Rendus.' He also states that the finest branches into which the processes of the nerve-cells divide, resemble the "elementary tubules" of the primitive fibres, and that the cells are connected with each other by their processes (p. 899). In the same volume (p. 956), M. Gratiolet informs the Academy that he described this anastomosis of the cell-processes as early as 1852. M. Gratiolet was evidently not aware

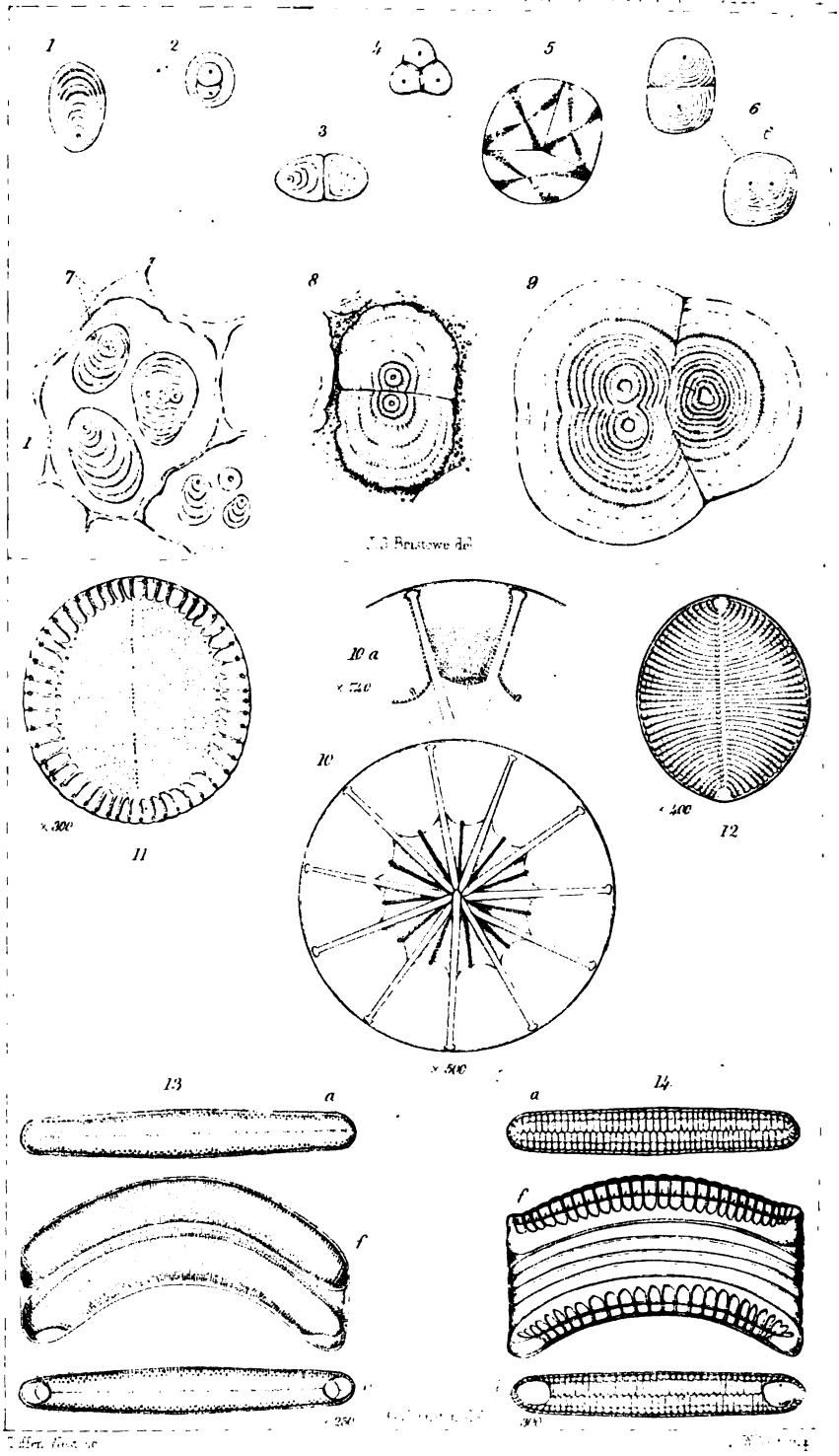
In 1856, the detailed inquiries were published in a quarto volume, and illustrated by figures. The doctrines, though not refuted, were received with hesitation on the Continent. Kölliker speaks with caution on the subject. He says that neither Stilling's nor his own preparations have convinced him that the parts described and represented are *tubular* elements. But while he refuses to accept the "questionable structure" as a normal part of the nerve-fibre, he does not thereby wish to stop any further inquiry, and adds, that when we consider the researches of Schultze on the olfactory nerve, and those of Remak, Leydig, and Häckel on the nerves of the *invertebrata*—researches which tend to show that the contents of the nerve-tubes either wholly or partially consist of fine fibres—we must be cautious in judging of statements like those of Stilling.* Mr. Lister attempts to account for this fibroid arrangement by supposing it to arise from the crystallization of the fatty constituents of the white substance during the process of hardening; but to me it does not appear to resemble anything of this description; for in form it frequently presents the appearance of a skein of thread more or less loosely tangled; whereas, in the crystallization of fatty substance, the fibres, however branched they may be, are not twisted and curled in different directions, but radiate in comparatively straight lines from a common centre.

For two years after the publication of the work already mentioned, Stilling had his attention constantly directed to these nerve-fibres, while engaged in his recent work, in which we find him reproducing with the greatest confidence the same doctrines of nerve-structure, and devoting to their illustration an entire folio plate, containing no less than fifty-one figures, beautifully executed, and representing the appearances in question with the greatest accuracy. But before I proceed to the *true* explanation of these appearances, it will be better to give a little more particular account of Stilling's latest descriptions, so that they may be more clearly seen to admit of this explanation.

1. The nerve-sheath consists of a thick network of the finest tubules or fibres, which cross each other, communicate, and take the most varied direction. From this thick network the fibres run—many of them separately—both

that two years earlier (1850) this anastomosis was described by myself, who, so far as I can find, was the first to announce the fact. ('Philosophical Transactions,' 1851, part, ii, p. 614.)

* 'Gewebelehre.' Dritte Auflage, 1859, p. 277.


1
2
3
4
5
6
7
8
9
10 a
× 740
10
× 500
11
× 300
12
× 400
13
a
f
14
a
f
× 250
× 300

DESCRIPTION OF PLATE I,

Illustrating Mr. Rainey's paper on the Formation of the Starch-granule.

Fig.

1.—Ordinary forms of starch.

2, 3.—Starch-granules; two joined together, producing an appearance considered to be the result of cell-multiplication by division.

4.—Three starch-granules similarly united.

5.—Three granules thus united, as seen by polarized light, from Crüger.

6, 7.—Starch-granules, called by author "compound granules."

8.—Two globules of carbonate of lime, joined together and coalescing into one; from calcifying shell of oyster.

9.—Large artificial calculi of carbonate of lime in progress of coalescence.

PLATE I (*continued*),

Illustrating Dr. C. Johnston's paper on Diatomaceæ, chiefly from Elide.

10.—*Asteromphalus centraster*, C. J.

a. Portion of the same, more highly magnified.

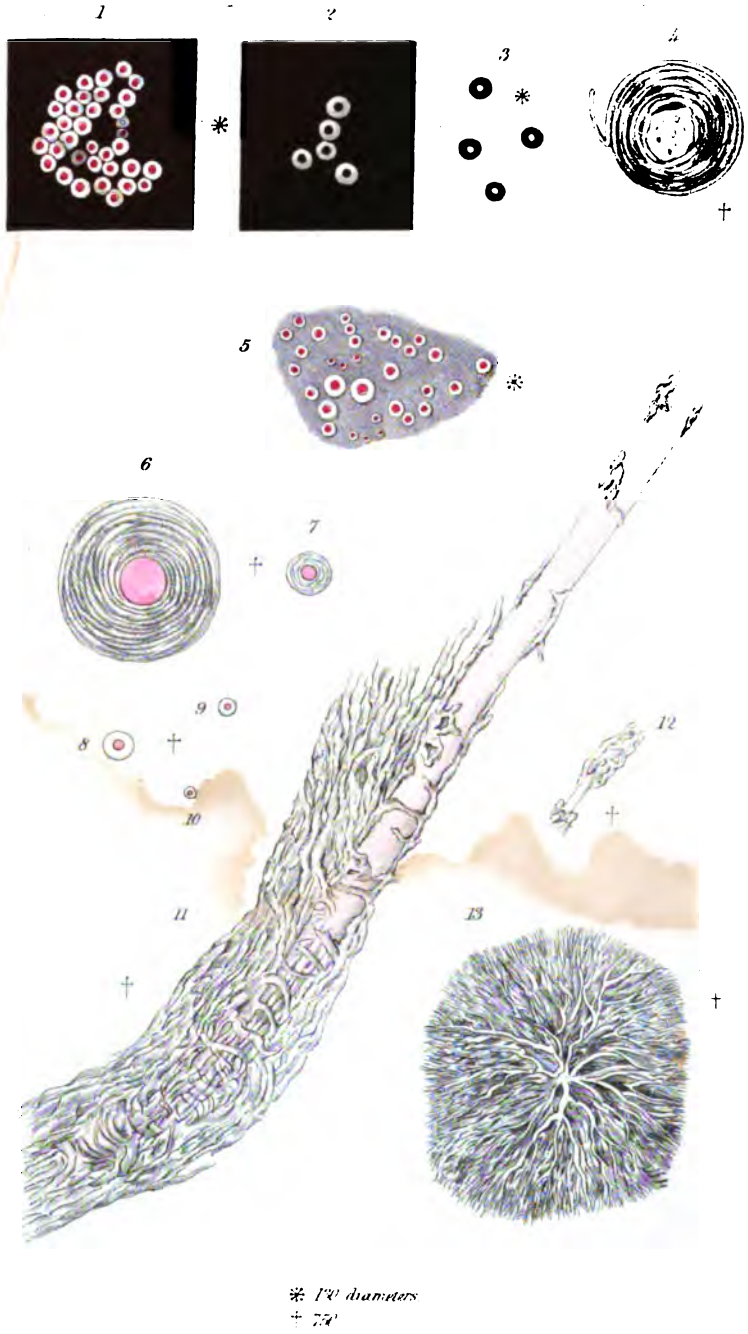
11.—*Campylodiscus marginalis*, C. J.

12.—*Cocconeis regina*, C. J.

13.—*Achnanthes angustata*, C. J.

14.— „ *costatus*, C. J.

a. Upper valve. *b*. Lower valve, side view. *f*. Front view of frustule.


1
2
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* 120 diameters
† 720

DESCRIPTION OF PLATE II,

Illustrating Messrs. Lister and Turner's paper on the Structure of Nerve-fibres.

Fig.

1.—Represents part of a transverse section of the sciatic nerve of a cat hardened by chromic acid, and tinted with carmine; the axial cylinder alone having received the colouring matter. The specimen was dried and viewed as an opaque object.

2.—Shows the appearance of thin transverse sections of some nerve-fibres from the same nerve, simply hardened in chromic acid, and examined moist by reflected light. The axial cylinder has, under this low magnifying power, the aspect of a mere space.

3.—Similar objects to those of fig. 2, but seen by transmitted light.

4.—A highly magnified transverse section of a nerve-fibre from the same source, prepared like those of figs. 2 and 3, and then tinted with carmine. The carmine colour is seen to affect only the axial cylinder and the investing membrane, which, at one part, is torn up from the fibre. This sketch also shows the faintly granular structure of the axial cylinder, and the irregularly concentric striation of the medullary sheath.

5.—A transverse section of a columnar portion of the spinal cord of a cat, also prepared with chromic acid and carmine, and examined moist by transmitted light. The fibres vary much in size, but all of them resemble those of the sciatic nerve in having the red axial cylinder surrounded by a ring of untinted medullary sheath.

6—10 are highly magnified views of some fibres in a section of the cord like that of fig. 5. They present the same characters as the fibres of the sciatic nerve.

11.—A fibre from a longitudinal section of a columnar portion of the cord, prepared in the same way. The axial cylinder alone is carmine coloured, and is, in some parts, stripped of its investing sheath, the fibroid arrangement of which is also displayed.

12.—A small fibre under similar circumstances.

13.—Fatty matter in a state of arborescent fibroid aggregation.

DESCRIPTION OF PLATE III,

Illustrating Professor Williamson's paper on the Structure of Crustacean Integuments.

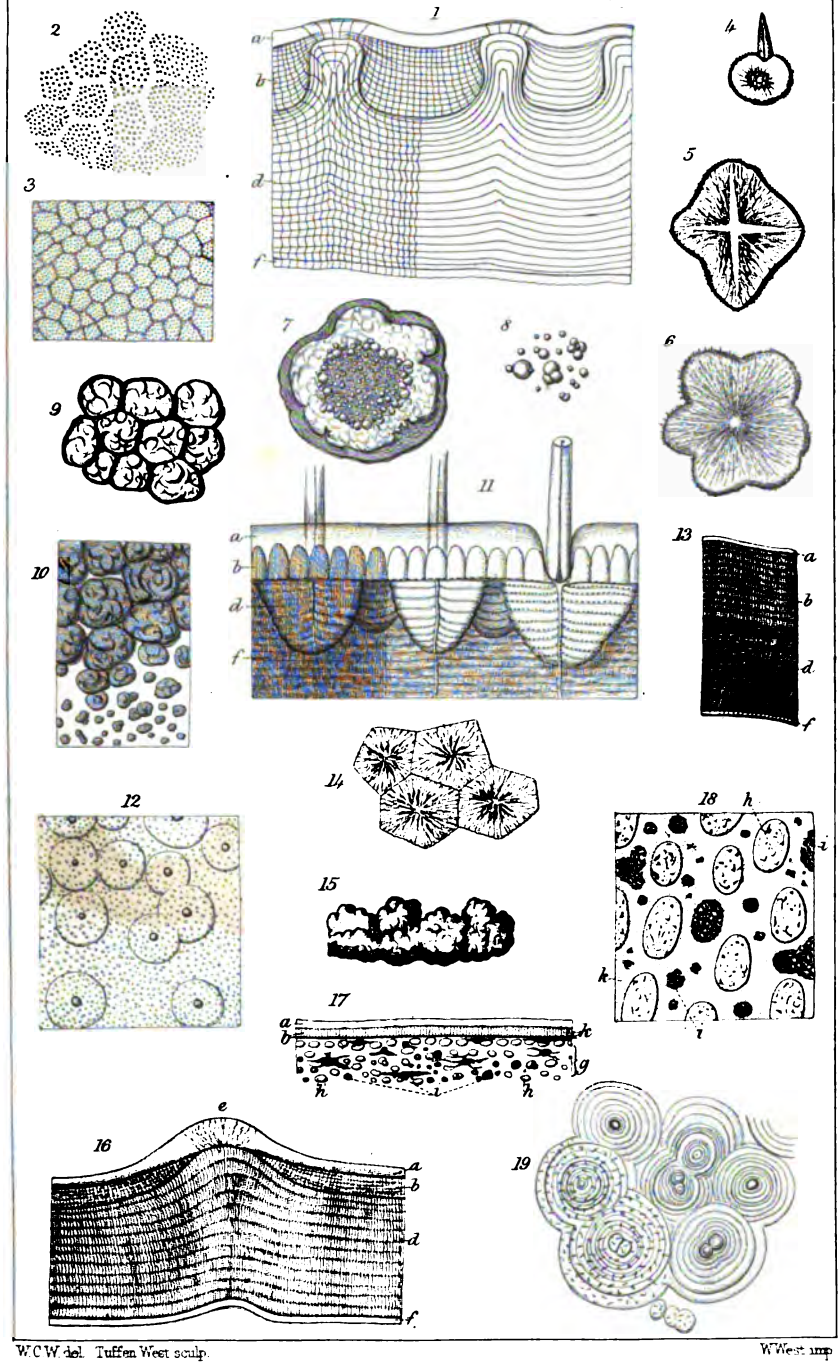
Fig.

1.—Diagrams of the layers in the shell of a crab.
2.—Grouped tubuli from above, areolar layer of common crab.
3.—Areolar layer, showing the very delicate areolæ in the shrimp.
4.—One of the calcified discs from the carapace of a shrimp, formed at the base of a short tubular hair.
5, 6.—Discs from the same after further calcification; in fig. 5 is seen a translucent crucial figure.
7.—Disc from the same in a less consolidated state.
8.—Detached granules from a similar disc.
9, 10.—Appearance of areolar layer in a shrimp after boiling with caustic potass.
11.—Vertical section, carapace of *Pilumnus hirtellus*.
12.—Horizontal section of the same, decalcified, as seen from above.
13.—Vertical section, crayfish.
14.—Horizontal section, lobster, immediately beneath the areolar layer.
15.—Vertical section of the same.
16.—Vertical section, claw of hermit-crab.
17.—Derm or "enderon," soft portion of integument of hermit-crab.
18.—The same, from above.
19.—Section of botryoidal concretionary masses from a small Australian crab.

The same letters are used to similar parts throughout.

a. Pellicular layer.
b. Areolar layer.
d. Corium calcified.
e. Tubuli.
f. Uncalcified corium.
g. "Derm" of soft carapace.
h. Its cells and nuclei.
i. Its pigment-cells.
k. Basement membrane.

In fig. 17, *b* indicates the corium and areolar layers blended.



W.C.W. del. Tuffen West sculp.

W.West imp.

inwards and outwards. Those which run outwards become connected with the sheaths of the neighbouring nerve-fibres; while those running inwards come into connexion with the *medullary* sheath (white substance of Schwann) and the axis-cylinder.

2. The white substance of Schwann consists of a numberless multitude of the finest fibres, which take the most varied course, but run mostly in oblique or in transverse directions, and establish a communication between the external sheath and the axis-cylinder.

3. The axis-cylinder consists of three layers, one within the other, each of which sends out, in horizontal and oblique directions, numberless ramifications, which cross the space, and so constitute the fibres of the white substance, and come into connexion with the so-called (external) sheath. Whether the inner or central portion of the axis-cylinder is hollow, or composed of the finest fibrils, is uncertain, but the latter is more probable.

Besides the parts just described, each primitive nerve-fibre contains an oleaginous fluid, which hitherto was considered to be included between the external sheath and the axis-cylinder, as in a hollow space or vessel. But this fluid is, in all probability, contained in the finest tubules of the white substance, as well as in those of the axis-cylinder and the sheath.*

The "elementary tubules" of which each primitive nerve-fibre is said to be composed are exceedingly small, varying from the $\frac{1}{1500}$th to the $\frac{1}{3000}$th of a line in diameter.

Now it would be very difficult to account for the production of such elementary fibres as these under the influence of chromic acid, however disinclined we might be to acknowledge them as parts of the normal structure, until further proofs were adduced; and therefore, if we really admit their existence—whether they be tubules or only simple fibres,—and consider, at the same time, the prolonged attention of Stilling to the subject, as well as the facts brought to light by Remak and others, we ought, I think, with Kölliker, to be cautious in pronouncing a decided judgment. But the question may be completely set at rest, for, as will presently be seen, these supposed elementary tubules, or fibres, have no actual existence whatever,—the appearances from which they have been inferred resulting solely from corrugations, ridges, or folds produced in the white substance by the action of the chromic acid.

* 'Neue Untersuch.,' 4te Lieferung, p. 708.

The medullary sheath, or white semi-fluid, is semi-fluid and exceedingly pellucid, of great refrangibility, extremely extensible, but inelastic, and of a peculiarly viscid nature, so that when its continuity is interrupted, or whenever it is in any way disturbed, it has little or no tendency to return to its original position; and, like other semi-fluid and viscid substances, may be drawn into fibres or into delicate expansions of extreme tenuity. In its natural position around the axis-cylinder (Pl. IV, fig. *a*), its outer and inner surfaces (*b*, *c*), where they are seen side by side at the lateral parts of the fibre, give rise respectively to the outer and inner contour or line; but if it constituted the *entire* fibre, instead of only a layer around the axis-cylinder (*a*), it is evident that it would be bounded only by a *single*, outer contour, or dark line, on each side. Now a fold or ridge (fig. 1) raised up from the white substance presents to an eye looking down on its convex surface the same appearance as such a fibre would present; that is, it appears as a fine tubule or fibre bounded on each side by a single dark outline. When I directed my attention to nerves hardened in chromic acid, with the special view of ascertaining the cause of the fibroid appearance, I soon became convinced, from many reasons, that these so-called fibres are produced in the way I have just stated. The first peculiarity likely to strike an observer is the unnatural thickness of the layer of white substance, and consequently of the entire fibre (fig. 2). This increase in diameter would of course be attributed by Stilling to the separation from each other of the so-called "elementary tubules," which on that account have a more striking resemblance, at first sight, to actual fibres. But if these were really fibres, there would be vacant spaces between them, whereas they are all connected together by intervening portions of the hardened and brittle, but extremely transparent white substance. Nothing at first sight can look more like fibres or tubules than the loops at *a a*, fig. 2; and yet, on closer examination, they were found to be only the rounded borders of portions of the white substance projecting from the surface; for they inclose a transparent layer which connects their edges with the rest of the primitive-fibre. On the opposite side, at *b*, is seen what might easily be mistaken for a *broken* fibre; but it is nothing more than the broken edge of a projection similar to those at *a a*, with a transparent and almost imperceptible layer of white substance connecting it with the general surface. In fig. 3, at *a*, the same appearance is still more satisfactorily explained; for here a piece of the rounded border of the pro-

trusion, with part of the transparent interior, has been broken off. It will be understood, then, that all the folds, ridges, or apparent elementary fibres represented in fig. 2, are connected together by an intervening layer of the white substance, which has a convex, concave, or some other kind of plane, surface. Sometimes the surface of a primitive-fibre, hardened in chromic acid, resembles a piece of parchment crumpled into a multitude of folds of different shapes and lengths, and loosely arranged around a central axis; and sometimes it presents very much the same appearance, and is indeed in the same condition, as the fissured bark of an old tree, or the shrivelled bark of a young twig torn while green from the parent stem. At the upper and broken end of fig. 2 the superficial parts of the folds or ridges have been brushed away, but the sharp edges of their bases may be distinctly seen. Fig. 3 represents a primitive-fibre deprived, in the same way, of the superficial parts of the folds, except at *a*; but the sharp and fractured edges of the subjacent substance from which they have been swept are very conspicuous, and have, in one place, a kind of spiral or concentric arrangement around the axis-cylinder, which axis is probably the cause that determines such an arrangement, under the corrugating influence of chromic acid. Figs. 4 and 5 represent two detached pieces brushed from the surface of a primitive-fibre. In both, the apparent elementary tubules or fibrils are connected by a thin layer of white substance; and in fig. 5, where this substance is bent in different planes, it is evident that every angular deviation from the plane surface gives rise to the appearance of tubule or fine fibre.

Although quite satisfied with the above explanation of the appearances in question, I thought that if similar or nearly similar results could be produced in the fresh nerve-fibre by simple mechanical disturbance or manipulation, and without the use of any chemical agency, the facts would be undeniably established. For the purpose of this inquiry, I examined on several occasions under the microscope some spinal nerves of the ox and of other animals, immediately after death, and moistened only with fresh serum of the blood. The primitive-fibres, when uninjured, had the well-known semblance of translucent tubes with double contours (as shown in fig. 6); and no traces of finer elementary tubules or fibrils could be discovered in them, even under high magnifying powers. But when the bundles of nerves were torn asunder, and finely separated by means of needles, the white substance assumed a great variety of appearances,

which were manifestly due to nothing but simple mechanical disturbance. The injury was often limited to the *sides* of the fibre, and consisted only of indentations or fissures, which were sometimes plain and smooth, as in fig. 7, and sometimes, as in fig. 8, more or less twisted into spiral ridges, which had a considerable resemblance to fine elementary fibrils. The white substance between the two contours, represented in fig. 9, had a completely spiral arrangement, and might, if insufficiently examined, have been compared to the fibres of a partially untwisted rope; *but* it evidently consisted of a continuous mass, in the same condition as a twisted cylinder of glass, so that the appearance of fibrils or tubules was caused by the prominent edges of the spiral. Sometimes (as in figs. 10 to 15) two portions of the white substance between the double contour was drawn asunder to a variable distance, and in such a manner that the intervening and viscid lamina, or expansion, was thrown into a series of folds which might readily have been mistaken for tubules. But these ridges or folds (represented by the light lines) were obviously continuous at their sides with the pearly transparent substance in the spaces between them. In fig. 16, a similar state of the fibre is very satisfactorily seen; for the lower portion (*a*) between the separation consists of fibre-like ridges, while the upper expansion (*b*) is only slightly undulated.

When the nerve-fibre was stretched and dragged, or otherwise rudely handled, the wrinkles and undulations were not confined to its sides, but extended over its entire surface, as represented in fig. 17. Sometimes they originated from between the double contour, where the white substance was frequently fissured or indented, and after a short but various course, they flattened and subsided into the surrounding surface, or intercommunicated as apparent fibres in a kind of anastomosis. This last-mentioned appearance is remarkably well seen in fig. 18. At the upper part of the fibre, on the left side, the white substance was thrown into a convolution, which gave it the appearance of having two double contours at that spot. Lower down was a thick convex elevation or fold, which stretched transversely across from one double contour to the other; and on either side of this were numerous smaller folds of precisely the same kind, and having a remarkable similitude to anastomosing fibres. In some parts (see fig. 19) the surface of the fibre consisted entirely of large convolutions like those of the cerebral hemispheres; while in other parts, as in fig. 20, these convolutions subdivided into apparent fibres or tubules. Even when the

contents of the nerve-fibre were squeezed out, they assumed the same diversity of form. Fig. 21 *a* is a large globule of white substance variously wrinkled; in two other globules (*b b*) the surfaces have been thrown into a kind of network of wrinkles or folds, like the surface of the fibre, fig. 18. In the globule (*c*) the ridges have a spiral arrangement; and at *d*, a fold or ridge arising from the inner contour, has exactly the appearance of a tubule or fine fibre; but near the centre of the globule, it subsides into the smooth convex surface which surrounds it.*

After I had observed all these appearances as the effects of manipulation, I carefully dissected another fresh nerve, and having selected some uninjured primitive-fibres, like the one represented in fig. 6, I introduced under the thin covering-glass a little acetic acid, and watched the result. The immediate effects were a multitude of very small depressions or pits, which showed like the fine marks of a mezzotinto engraving (see fig. 22). These were succeeded by deeper and larger depressions prolonged in different directions, so that the intervening elevations might have easily been mistaken for tubules. Sometimes these ridges were more or less longitudinal, but short, and resembled the elevations in the fissured bark of a tree (see fig. 22). Sometimes they ran transversely and obliquely, and joined in a complete network; or turned about in loops, or in spirals like the spirals seen at the cut ends of fibres hardened in chromic acid (see figs. 22 and 23). It was evident that all these appearances were due to the same state of the white substance as that which has been shown to be produced by mere mechanical disturbance.

* Stilling maintains that in the *fresh* nerve-fibre, the inner, like the outer contour, does not form a continuous or uninterrupted line, but *splits* in various ways, and *sends processes to the axis-cylinder;* and that under a low power (his figures are magnified 1100 diameters) it seems to have a continuous boundary line only because the "elementary tubules or fibres" proceeding from it cannot be seen on account of their extreme transparency in the fresh state. "Wenn man aber bei stärkeren Vergrösserungen sorgfältig untersucht, so wird man finden, dass die innere Contour, eben so wie die äussere, nicht stets eine linienförmige Begränzung bildet, sondern vielfach unterbrochen ist, sich theilt, Fortsätze gegen den Axencylinder hin aussendet, und nach kürzerem Verlaufe in Continuität abgebrochen anscheinend aufhört, und dass sie nur deshalb den Auschein einer Begränzungslinie giebt, weil die nach innen wie nach aussen auslaufenden Fasern oder Röhrchen, wegen ihrer Durchsichtigkeit im frischen Zustande, nicht erkannt werden können." ('Neue Untersuch.,' 4te Lief., pp. 730-31.) These divisions of the inner contour, as well as the processes or fibres which he believes it sends to the axis-cylinder, are nothing more than the indentations, corrugations, and folds shown in figs. 17 and 18 to result from mere mechanical injury.

With regard to the structure of the external or membranous sheath of the primitive nerve-fibre, there is some difference of opinion amongst anatomists. According to Schwann, and Todd and Bowman, it is a structureless, homogeneous, and finely granular tissue; while Fontana, Valentin, Remak, Henle, and others, have described it as composed of fibres which cross each other in different directions. According to my own observations, it consists of fibres of different shapes and sizes, but sometimes of such extreme delicacy, that when in close apposition they appear to be fused, as it were, into a homogeneous, finely granular, but nucleated membrane. Some of these fibres are broad, flat or riband-shaped, of a faint or shadow-like aspect, and spotted at intervals with exceedingly pale and delicate granules; they are joined together at their edges and proceed from the whole breadth of their nuclei, which are occasionally oval, but generally very elongated and spotted with the same kind of granules as the fibres; they are frequently found covering, as with a continuous nucleated membrane, the entire surface of many of the smaller primitive-tubules. Other fibres composing the external sheath are of smaller diameter, but sometimes less delicate and branched; they proceed from the *ends* of their nuclei, which are also occasionally coarser and of darker outline.

About two years back, while examining some sections of the spinal cord of the Calf and of other *young* animals, prepared according to my own method, I was surprised at finding that the whole of the *white columns* were studded with nucleated *cells* which adhered to the sheaths of the primitive-fibres, and occupied the spaces between them. Now, there is reason to believe that in the adult these *cells* become developed into filamentous tissue; for in the ox and other full-grown animals I found that the *cells* had disappeared, but that their *nuclei* were still present between the primitive-fibres.* In a short exposition which I gave, last summer, at the University of Edinburgh, of some of the most important points in the anatomy of the spinal cord, I alluded to the presence of these nucleated cells in the white columns. It appears, however, that Messrs. Lister and Turner were not

* For further information on this subject, see my late Researches, read before the Royal Society in 1858, and published in the first part of the 'Philosophical Transactions' for the present year. I may also take this opportunity of calling attention to an *Outline* of the Anatomy of the Spinal Cord, published in No. iii, 1858, of Beale's 'Archives of Medicine,' and written for the use of those who have not time for reading the more detailed treatises.

able to find them or their nuclei in sections simply hardened in chromic acid, but noticed occasional nuclei on the sheaths of the fibres in the sciatic nerve. In most parts of the cord, when simply hardened in chromic acid, it is certainly very difficult to detect them; for, being about the size of the cut ends of the smaller fibres and blood-vessels, they are scarcely distinguishable in the confused and badly defined matrix in which they are imbedded. Stilling, even with a magnifying power of 1100 diameters, has failed to detect these bodies in the cord of the Calf. But in preparations made according to my method they may be seen with the greatest facility under a power of 400 diameters, in consequence of the superior definition. Even with the simple use of chromic acid, however, they may be very readily found towards the lower end of the cord,—in the coccygeal region; for here the white columns are very much subdivided by numerous ramifying fissures containing pia mater and connective tissue, in which the cells or their nuclei abound.

Description of Two New Species *of* Staurastrum, *by* W. Archer; *a* New Genus *and* Species *of* Desmidiaceæ, *by the* Rev. N. V. Dixon; *and some cases of* Abnormal Growth *of* Desmidiaceæ, *by* W. Archer.

(Read before the Dublin Natural History Society, on Friday, June 3d, 1859; extracted from the 'Natural History Review and Quarterly Journal of Science,' for Oct. 1859.)

In these days of cancelling from our lists, and their consolidation with others, of numerous species, or reputed species, in the various walks of natural history,—and this, no doubt, in many cases, with much reason,—it may appear unjustifiable rashness and temerity on my part to come forward for the purpose of describing the following two new forms to be added to our lists of Desmidiaceæ. But in a more extended point of view, in regard to what is a species and what is not, it seems to me that naturalists are prone to err in one of two directions: they either restrict the number of species in their lists within too narrow limits, or inordinately increase their number by giving a name and specific rank to almost every variation which they encounter. On the one hand, because, between two hitherto recognised distinct, but allied species,

there are occasionally found forms, as it were intermediate, connecting them, it is assumed that these two original forms must necessarily make but one species. On the other hand, those naturalists might possibly be not wanting who would feel inclined to consider not only the two original, but also one or several of those intermediate forms, as themselves species. Both extremes, as it seems to me, may be wrong. Might it not be expected to be the case that the limits of variation of each of the two original species, so nearly allied, might, so to speak, so touch each other at the margin, as to seem to unite them together, and give rise to the assumption, always plausible, but perhaps not always correct, that one of the original species could (and does), by a series of transitions, pass into the other? If any one species become modified, is it not to be expected that the characters of the most nearly allied form, and not those of one remote in affinity, will be those which, to a greater or less degree, it will be likely to simulate? Under this hypothesis, the two original forms would still justly be considered true and distinct species—in contradiction to the opinion of the former class of naturalists —while the forms intermediate would be but variations (perhaps but of a temporary or local nature), some derived from one species, some perhaps from the other, and could by no means be looked upon as true species—in opposition to the views of the latter class of naturalists. I do not mean to intimate, when a hitherto acknowledged species is rejected, that I imagine the step always to be an erroneous one, for he who successfully demolishes the spurious claims of a mere book-species does science a good service; but it seems to me that what I have tried to express is a state of things, the possibility of the existence of which, by those who are anxious to suppress species, may sometimes be lost sight of or ignored.

There can be no doubt, however (and especially amongst microscopic forms), that our lists are more or less encumbered with the redundant names of false species, which further research will doubtless eventually prove. Many forms which now pass under distinct names may hereafter be found not worthy to take specific rank in our systems. And here it is that the difficulty lies. In order to prove the identity of two reputed species, over which there hangs a doubt, not only must the happy opportunity be afforded of tracing the organism through its whole course of life, but, on the part of the observer, the requisite leisure and patient assiduity must not be wanting.

No doubt it is much easier to describe a new species than to demonstrate that two, or perhaps more, familiar forms are but

different states or phases of one and the same organism. Nevertheless, when a form undescribed and quite distinct from any of its nearest allies in the same genus, and distinguished by marks as decided and striking as those by which species, which are universally acknowledged, are separated, presents itself occasionally, perhaps abundantly, and which may as likely be met with by other observers, it seems to me right, nay essential, that it should be distinguished by a name, and its diagnostic characteristics carefully recorded.

I offer the foregoing remarks, which it may be proper to state were written considerably before the Hymenophyllum discussion arose, as apologetic for my venturing to bring forward the following description of two species of Staurastrum; and yet, perhaps, they are not strictly applicable, for these new forms appear to me abundantly distinct from every other species, and in no way to be mistaken for mere intermediate or gradational variations. To some, however, it may seem premature to describe them without knowing the sporangial state. It will be recollected, however, that, of very many of the species, as described in Ralfs' 'British Desmidieæ,' the sporangium is not known, nor, when known, can there usually be important distinctions drawn from it. I trust the following may serve as a description of the new forms:

Family DESMIDIACEÆ.

Genus STAURASTRUM, *Meyen, Bréb., Ralfs*, &c.

Staurastrum oxyacantha (sp. nov.)

Specific characters: Frond rough with minute granules; segments broadly fusiform, with incurved processes; end view tri-radiate, each side having, disposed at equal distances, a pair of depressed, slender, subulate, acute spines.

Locality: Pools near "Sugar-loaf" Mountain, on the Roundwood road; rare.

General description: Frond nearly as long as broad; segments rough, with minute granules, broadly fusiform, inner margin somewhat more turgid than the outer, and forming at constriction a broadly triangular notch, tapering at each side into a colourless process incurved or converging with that of the opposite segment, having the granules theron arranged in transverse lines, and cleft at the extremity into three or four minute subulate spines; frond furnished at ends upon each side with a pair of slender subulate, acute, depressed spines, which are apparent in the front view. End

view tri-radiate, having projecting from each side at equal intervals the parallel pair of spines unaccompanied by others; processes terminating each angle in this view, straight, elongate; endrochrome restricted to the centre, triradiate.

Length of frond, $\frac{1}{710}$ of an inch; breadth, $\frac{1}{580}$ to $\frac{1}{330}$; breadth of constriction $\frac{1}{2330}$.

Plate VII. Fig. 1, front view; fig. 2, end view.

This form appears to me very distinct from any described. The presence of the conspicuous pair of acute spines projecting from each margin at end view distinguishes it from all but *Staurastrum vestitum*, but in that species the spines, which are apparent only in the end view, are emarginate at the ends, and often accompanied by others of considerable size; and indeed, even the smaller are themselves often emarginate; moreover, in the front view it differs by its converging process. It is also considerably smaller than *Staurastrum vestitum*, being not more than half its width, which diameter in that species greatly exceeds its length. The converging processes in front view are somewhat like those of *S. cyrtocerum*; but in that species there are no spines at the ends of the fronds, and the processes in end view are not so much prolonged, and are curved in place of straight. The presence of the marginal spines in end view, and the incurved, not divergent, or parallel processes in the front view, distinguish this from *S. paradoxum*, *S. gracile*, and *S. polymorphum*.

Staurastrum nitidum (sp. nov.)

Specific characters: Frond rough at the ends, with a series of papilla-like granules; segments broadly elliptic; end view triangular; sides convex, with a submarginal series of papillæ; angles not inflated, mucronate.

Locality: Pools near "Sugar-loaf;" rare.

General description: Fronds about as broad as long; segments broadly elliptic, inner margin somewhat more turgid than the outer, sub-mammillate at each side, terminated by a mucro, and on the outer margin rough with a series of minute papillæ, otherwise smooth; constriction forming a broad notch, with an acute angle; end view triangular, sides convex, with an inwardly curved sub-marginal series of papillæ, their summits directed somewhat towards the angles; angles not inflated, the last papilla forming a terminal mucro; endochrome in both views disposed in a radiate manner; gelatinous investment evident.

Length of frond, $\frac{1}{340}$ to $\frac{1}{315}$; breadth of frond, $\frac{1}{340}$; breadth at constriction, $\frac{1}{1050}$ of an inch.

Plate VII. Fig. 3, front view; fig. 4, end view.

This, although not a complex form, owing to its brilliant and beautifully radiately-disposed endochrome (in front view almost in fillets), is an extremely pretty species. In end view its non-inflated mucronate angles and series of papillæ distinguish it, I think, from every other Staurastrum. In front view it somewhat resembles *S. asperum*, Bréb., *a*, but the minute spines on the outer margin, in that species, are usually emarginate or cleft at the ends, or dilated, and the segments are not mucronate at each angle, nor is the endochrome radiately disposed. In the form in question, the convex sides, mucronate angles in end view, and granules not scattered, distinguish it from *S. punctulatum*. I do not think I need contrast it with any other species, and I believe that both the foregoing forms have only to be seen, when their perfect distinctness would be at once apparent.

New Genus *and* Species *in the* Desmidiaceæ.

I beg leave to submit to the notice of your Society the following account of a form of Desmid, which I have lately met with in this neighbourhood, and which I believe has not hitherto been described. The frond, as represented in Plate VII, figs. 5—7, is simple, compressed, with a deep and acute gaping constriction between its segments, which are three-lobed, the line separating the extreme from the basal lobes being parallel to the line of separation of the segments. It has no inflation on its surface, but exhibits on its margin a few mucronate spines. This form appears to me to be generically distinct from both Micrasterias and Euastrum: from the former in the direction of the separation of its lobes, from the latter in the absence of inflations. In these characteristics it agrees with *Micrasterias oscitans* and *M. pinnatifida*, Ralfs, as well as with the form *Holocystis oscitans*, Hassall, described by Dr. Hassall, and referred to by Mr. Ralfs ('British Desmidieæ,' pp. 69—77), and it is worth considering whether these forms should not be all grouped together in a new genus. Before proceeding, however, to give the complete description of this proposed genus and the three species which it would contain, I beg leave to offer a few remarks on the different manner in which the segments are divided in those Desmids which have lobed or divided segments, and

which for this reason I take the liberty of calling *Schizomerous* Desmids.

The typical mode of division (as exemplified in *Euastrum pinnatum*, *E. oblongum*, &c.) appears to be into three portions or *subdivisions*: the first, next the line of separation of the segments, extending across the frond, and embracing the two basal lobes; the second, including the median lobes; and the third, the extreme or end lobe. This last, or third subdivision, is the most constant. The two former are frequently represented by a mere sinuosity or shallow indentation where the third is distinctly developed, but we never find the first subdivision distinct, and the second and third imperfectly separated. The whole three, indeed, may be merely marked by slight sinuosities, as in *Euastrum cuneatum*, but if any one is separated, it is the third; and this, I may observe, is the order of development of the subdivisions in the growing segment of the typical Micrasterias. The new segment is first hemispherical; the third subdivision is then developed; and afterwards the first and second are separated.

For the purposes of description these three subdivisions might be denoted by the letters *a*, *b*, *c*; and their partial or complete development marked as follows:—When the subdivisions are distinctly separated, their symbols might be separated by commas, thus, *a*, *b*, *c*; when any two or more are merely marked by a sinuosity, they might be represented thus, $a \frown b$; and if there is no trace of separation, thus, *ab*; and if, at the same time, the direction of the lines separating the subdivisions were noted, the full description as regards the divisions of the segments would be given. Thus:

Euastrum cuneatum	would be represented by	$a \frown b \frown c$.	
„ *pinnatum*	„	„	*a*, *b*, *c*, parallel.
„ *oblongum*	„	„	*a*, *b*, *c*, subradial
Micrasterias denticulata	„	„	*a*, *b*, *c*, radial
Euastrum pectinatum	„	„	$a \frown b$, *c*, parallel.
And our new form	„	„	*ab*, *c*, parallel.

The direction of the lines of separation of the subdivisions in the Schizomerous Desmids varies from parallelism to true radiation, and at the same time the intervals between the subdivisions close, so that in *Micrasterias denticulata*, *rotata*, and *fimbriata*, the frond appears almost entire with radial lines on its surface. I think regard ought to be had to this characteristic in placing the genera and species of Euastrum and Micrasterias between the filamentous forms on the one hand and the Cosmaria on the other; that the forms with parallel subdivisions should come first; the Euastra, so well

marked by their peculiar inflations, a few of which are parallel, but the majority subradial, next; and the Micrasterias last, terminating with the radial closed species, from which the transition would be easy to the Cosmaria, among which traces of radiation still appear in the endochrome of *C. Ralfsii*, in the ridged surface of *C. undulatum*, and the crenated margin of other species. The whole group of Schizomerous Desmids then might be distributed among three genera—the first containing *M. oscitans*, *M. pinnatifida*, Ralfs, *Holocystis oscitans*, Hassall—if this be distinct from *M. oscitans*, which appears doubtful—and our new form; the next being Euastrum, and the last Micrasterias. In conclusion, I beg to mention that I owe the drawing which accompanies this paper to the kindness of Mr. Archer, whom I consulted when I first met with the new form under discussion, and to whom I forwarded the gathering in which it occurred for further examination; and that the following detailed generic and specific descriptions have been drawn up by the same gentleman.

Family DESMIDIACEÆ.

TETRACHASTRUM (*gen. nov.*)*

Generic characters: Frond simple, compressed, deeply divided into two three-lobed segments; the basal lobes projecting horizontally, broadest within and attenuated outwards; end lobe expanded into two lateral attenuated projections parallel in their direction with the basal lobes; ends straight, or convex, or having at the middle of the rounded ends a very slight concavity.

General generic description: The fronds are simple, as long as or longer than broad, compressed, without inflations, deeply divided into two segments by a constriction, forming a broad acute-angled notch; each segment constricted by a broad notch or sinuosity upon each side into two *subdivisions* forming three lobes, the basal lobes broadest within and attenuated outwards, not radial, but extending horizontally

* From τέτραχα, *in four parts*, in reference to the fourfold division of the fronds, which is most conspicuous in *T. oscitans* and *T. pinnatifidum*, and ἄστρον, *a star*. This latter term, in its usual sense of a radiate form, is not a *descriptive* one, as applied to our new genus; but I adopt it because it occurs in the names of the other two genera of the same group, and I wish to mark their mutual affinity. Moreover, the term ἄστρον is not more inapplicable, on this ground, to the fronds of the proposed genus than it is to those of several species of Euastra,—*E. cuneatum*, &c., for instance.—R. V. D.

and parallel in their direction with those of the opposite segment; the end lobe expanded laterally into two attenuated projections, which are horizontally disposed, and parallel in their direction with that of the basal lobes, so that the entire frond is of a pinnatifid character; the ends of the fronds convex, straight, or having at the middle a very slight concavity or depression, not emarginate.

Tetrachastrum mucronatum (sp. nov.)

Specific characters: Frond longer than broad; ends rounded, having a slight central concavity; end lobe having its lateral projections terminated by a mucro; basal lobes broadly and bluntly triangular, having at their magin at each side either one, two, or three minute mucro-like spines; empty frond punctate, the puncta scattered.

Symbol: *ab*, *c*, parallel (*vide supra*).

Locality: Bog near Carrickmore, Co. Tyrone.

Measurement: Length of frond, $\frac{1}{187}$; greatest width, $\frac{1}{235}$; width of neck, $\frac{1}{375}$; diameter at constriction, $\frac{1}{680}$; greatest depth, $\frac{1}{350}$ of an inch.

Plate VII.—Fig. 5, front view with endochrome; fig. 6, empty frond; fig. 7, outline of side view; fig. 8, outline of transverse view.

General description: The frond in this species is large, smooth, entire, about one fourth longer than broad; in the front view divided into two segments by a deep constriction, forming an acute-angled straight-sided notch, not linear, but broadest at the outside. The segments are constricted about two thirds of the way from the base by a rounded sinuosity, causing the basal lobes to be of a bluntly triangular outline, straight on the lower, turgid or convex on the upper margin, and furnished thereon with one, two, or three minute mucro-like spines, one always at each basal angle. The basal lobes slope upwards to form a broad neck, uniting the terminal lobe to the basal portion: supposing the end to be *absent*, the frond would be orbicular. The lateral projections of the end lobe have their extremities tipped by a mucro, and somewhat projected downwards. Ends of the fronds convex with a *gentle* central concavity. In the side view the frond is smooth, about four times longer than its greatest depth; the central constriction is rather deep; the segments in this view ovate, turgid near the constriction, somewhat tapered towards the ends, which are rounded. The transverse view is broadly fusiform; the endochrome rich green, with scattered granules. The empty frond is punctate, the puncta scattered.

By attention to the generic characters as given above, this species can of course be readily distinguished from every other Desmidian, *Micrasterias oscitans*, Ralfs, and *M. pinnatifida*, Ralfs, excepted. The presence of the marginal mucronate spines, and of those terminating the lateral projections of the end lobe, combined with the absence of the incised extremities, as well as the frond being longer than broad, at once distinguish this from both those species, which, as a matter of course, I here include in this genus. It may be advisable here to transcribe from 'The British Desmidieæ' (pages 76, 77) the specific characters of both those two species, the first under the name of—

Tetrachastrum oscitans = *Mic. oscitans*, Ralfs, *Holocystis oscitans*, Hassall.

"Frond with convex ends [segments constricted], lobes [horizontal] conical, bidentate."

The characters here placed between brackets become generic by transferring this species to this new genus, but as it was included in Micrasterias by Ralfs, they were necessarily introduced as specific distinctions from the proper species of that genus. From the remarks in the preceding part of this paper on the new genus, it will, I hope, be admitted that they are really generic. In order to distinguish this species from *Tetrachastrum mucronatum*, they are not requisite, as the bidentate extremities to the lobes, with the absence of the mucros, and the frond being nearly about as broad as long, readily do so.

The remaining species will be—

Tetrachastrum pinnatifidum = *Micrasterias pinnatifida*, Ralfs.

"Frond plane, its ends straight [segments deeply constricted], lobes [horizontal] triangular, bidentate."

The same characters which distinguish the preceding species from *Tetrachastrum mucronatum* also separate this, which is moreover much smaller. It appears to differ from the preceding by its much smaller size, straight or slightly concave ends, more tapering lobes, and paler colour.

There can be no doubt, it is imagined, that the view taken above is correct in defining this genus as three-lobed, that is, with two basal lobes and a laterally expanded terminal lobe, and not four-lobed, that is, counting the lateral projections of the end lobe as two, which would involve the necessity of

describing these forms as truncate, and without a terminal lobe. The end lobe in these forms is equivalent to the same portion in *Micrasterias rotata*, or *M. Crux-Melitensis*, and differs by having its more extended lateral projections not divergent, but, as above described, projecting horizontally and parallel in direction with the attenuated basal lobes.

The following synopsis of the Schizomerous Desmidian genera, and of the species of Tetrachastrum, will, it is hoped, assist in conveying, in a succinct manner, the views put forward above, as well as the end sought to be accomplished in the present paper by the institution of the genus.

Frond simple, compressed, deeply constricted, segments lobed or sinuate (Schizomerous); lobes either incised, sinuate, or entire.

- Frond lenticular, as long as or longer than broad; segments usually semi-orbicular, five- or rarely three-lobed (with three, or rarely two subdivisions, *a*, *b*, *c*, or *a*⁀*b*, *c*); lobes radiant, incised or dentate, rarely only sinuate, widening outwards; central constriction usually linear. *Micrasterias*.
  (*Vide* 'Brit. Desmidieæ,' p. 68, *et seq.*)
- Frond longer than broad; segments more or less conical, five- or three-lobed, or sinuated (with three or two subdivisions, either *a*, *b*, *c*, or *a*⁀*b*, *c*, or *ab*, *c*, or rarely *ab*⁀*c*), possessing variously disposed, circular, inflated prominences; ends emarginate, or rarely with merely a concavity; central constriction linear. *Euastrum*.
  (*Vide* 'Brit. Desmidieæ,' p. 78, *et seq.*)
- Frond about as long as or longer than broad; segments three-lobed (with two subdivisions, *ab*, *c*), without inflated prominences; basal lobes horizontal, attenuated outwards, end lobe expanded laterally, its lateral projections parallel in direction with the basal lobes; ends straight or rounded, entire; central constriction forming an acute-angled spreading notch:

Tetrachastrum.

Frond longer than broad; segments constricted about two-thirds of the way from the base; lobes mucronate, their extremities not bidentate. *Mucronatum.*

Frond as broad as or slightly broader than long; segments constricted about half-way from the base; lobes not mucronate, their extremities bidentate.

Frond with convex ends; lobes conical; colour rich green. *Oscitans.*

Frond with straight ends, plane; lobes triangular; colour pale. *Pinnatifidum.*

Notice *of some* Cases *of* Abnormal Growth *in the* Desmidiaceæ.

It has occurred to me that the accompanying sketches, representing an abnormal mode of growth in the Desmidiaceæ, exhibiting, as they do, an appearance so curious and unusual, might possess some interest for the students of that family. I am aware that, in Mrs. Herbert Thomas's interesting communication ('Quarterly Journal of Microscopical Science,' vol. iii, plate v, figs. 17 and 18), that lady has figured a very similar case in *Cosmarium margaritiferum* to that shown in my drawing of *Staurastrum dejectum;* yet I have thought it might be worth while to figure some examples of the phenomenon still farther carried out in other genera, although it may be quite possible that even more curious aberrations may have been met with by other observers.

The first case of this mode of malformation to which I shall direct attention is a monstrosity of a variety of *Micrasterias Jenneri* (Plate VII, fig. 9). Here the intervening growth, produced after the mode which prevails in the Desmidiaceæ, between the two older segments of the original frond, and which, in the normal condition, ought to have formed two new segments, forms a somewhat quadrate expansion, but has not assumed any definite outline. We find it within filled with endochrome, similar to the parent segments, to about the dimensions of one of which it has attained. It is about the simplest form of the irregularity under consideration which I have to bring forward; the intervening new portion forming only an irregular, shapeless growth.

I here wish to draw attention in passing to the form itself

(fig. 9), a fair idea of which in the normal state can be obtained by imagining the irregular central growth as absent, and the two older segments in apposition. It will be seen that this variety agrees with *Micrasterias Jenneri*, Ralfs, variety β, in the superficial granules being somewhat large, giving a somewhat dentate or roughish appearance to the margin, but it differs from both varieties, α and β, by its lateral lobes not being bipartite, and of course wanting their emarginate subdivisions. Thus, if Mr. Ralfs justly called this species, both α and β, puzzling, the drawing before us exhibits a form even more so (vide 'British Desmidieæ,' p. 76). On account of the lobes not being incised, as just pointed out, this form (of course I need not repeat that I do not allude now to its abnormal irregularity) becomes, I think, likely to be mistaken for an Euastrum, to which genus it closely approaches through *E. oblongum*. Nor is the resemblance lessened by there occurring occasionally specimens with the incisions between the segments, not linear, and, therefore, the lobes not closely approximate, but spreading and sinuously lobed. However, the absence of any inflations, when viewed laterally, as well as the want of a terminal linear notch, though there is a slight concavity or depression at the ends, whilst the lobes are cuneate and more radiant, exclude this form from Euastrum. I would here then, take the opportunity to characterize this plant thus :—

Micrasterias Jenneri, Ralfs, var. γ.

Granules giving a rather rough appearance to the margin, lateral lobes concave, not bipartite, without emarginate subdivisions.

Locality: Bog, near Carrickmore, county of Tyrone. This very interesting variety occurred in the gathering kindly forwarded to me by the Rev. R. V. Dixon, and which also contained his new form, *Tetrachastrum mucronatum*.

In the monstrosity of *Staurastrum dejectum*, as shown in the drawing (fig. 10), we have both the new segments well developed, and each possessing in the front view its own proper laterally projecting spines; but the interposed segments remain confluent throughout a portion of their terminal margins, forming a bluntly triangular notch at the sides, the whole making but one entire cavity, with the endochrome loosely scattered within. In the next case, that of *Arthrodesmus incus* (fig. 11), the resulting fusion of the new growth, which ought to have formed two new segments, is even greater than in the preceding instance, so that the

monstrosity almost represents an individual of three segments, so to speak. Here the interposed new growth has formed, projecting to each side, but one angle, looking as if but one new segment only had been formed, whereas, it must be due really to both segments and spines of the recently-grown portion being confluent. Of this malformation of *A. incus* I have on several occasions seen specimens.

In the next drawing, showing a remarkable monstrous growth of *Euastrum didelta* (fig. 12), we have a case somewhat similar to the preceding, but presenting additional odd aberrations. The upper and lower portions of the figure represent the side view of the older segments; between them the new growth has been formed; but here not only does the direction of the axis of growth assume a course at right angles to the older segments, but, what is curious, the plane of the new growth is at right angles to that of the older. In other words, the new growth, which has formed almost what might be called a new frond, not only has its ends projecting at right angles to the ends of the original one, but it also presents a front view, while the older segments show a side one. The interposed new growth, projecting laterally, has formed the usual linearly notched ends of the species, but one of them has assumed a twist obliquely out of the straight direction. The irregular space towards the centre of the specimen, as represented in the figure, denotes a portion of the side of the boundary wall, which, upon its inner surface, is there destitute of chlorophyll granules, affording an opportunity to look into the central cavity, which thereabouts is more or less empty, but the entire specimen being otherwise, and to all extremities filled with endochrome, in the ordinary manner, as in a normal individual.

I exhibit a nearly similar case in *Euastrum insigne* (fig. 13); but the new growth has not assumed a different plane from the old, and it is not so deformed in appearance. Of this monstrosity I have met with two examples. The remaining case is represented by the two drawings which show a state of *Tetmemorus Brebissonii* (figs. 14 & 15), somewhat similar to the preceding condition of *Euastrum didelta* and *E. insigne*. In one the intervening growth has caused the old segments to become somewhat twisted in regard to each other, and, as in the preceding instances in Euastrum, it has assumed a direction at right angles to the axis of the older segments. The last sketch, (fig. 15,) which represents a second instance met with by me of this phenomenon in the same species, shows that the lateral extremity to the right is really what ought to have been normally the new segment on-

a line with the lower older segment, and that projecting to the left the same for the upper, by reason of the fresh accession to the mass of endochrome, with its central series of corpuscles, being continued in an uninterrupted, curved manner from each of the older segments into the new. But the new laterally projecting segments do not in either instance form an equally armed cross, for what is wanting in their length as well as breadth, as compared with the old, goes to make up a somewhat quadrate central inflation. Tetmemorus not being a compressed form like Euastrum, there is not the same opportunity for the change of plane of growth shown by the case in that genus (fig. 12), but that the new growth has assumed a slight twist, is shown by the different relative positions of the terminal emarginations.

The first figure of an abnormal Tetmemorus (fig. 14), shows another state, though not bearing any connexion with the curious aberration of the external form, and that is the disposition of the cell-contents. The entire endochrome has become transformed into four green and four brown bodies, the latter the smaller, and smooth in outline. This, however, does not appear to have any dependence on the external abnormal condition, for I have frequently noticed the same transformation of the cell-contents, especially in this species, in the ordinary normally formed individual, as well as in many other species—for instance, in *Tetmemorus lævis*, *Micrasterias denticulata*, *Euastrum didelta*, several Closteria, and many others; and often to the entire absorption of the cell-contents to produce these spore-like bodies. In *Tetmemorus Brebissonii* I have seen from one to a dozen or so of these bodies, more often four only, sometimes green, sometimes red, and sometimes alternately red and green. I have not been able to see any further development of those spore-like bodies. The abnormal specimen from which the figure was taken I kept on a slide moistened for many weeks, but no alteration took place in this or any other respect, save that the red bodies, from being undefined, grew more and more smooth in outline. These are, doubtless, similar productions to those figured in the 'British Desmidieæ,' pl. iv, fig. *f*, as occurring in *Desmidium Swartzii*. There, however, there is but one spore-like body formed in each joint. I have myself met with this species in the state so admirably figured in Ralfs; and though I kept the specimens for some time living, no further alteration took place beyond the decay of the old filament; and the spore-like bodies themselves subsequently perished. Bodies, which I suppose are of a similar nature, as is well known, are occasionally met with in species of

Spirogyra, and which, as here, not being the result of conjugation, are formed by either a portion or the whole of the green contents of a single joint being absorbed in their production, and are spherical and spinous. My friend, Mr. Edward Crowe, lately showed me specimens of Zygnema, in which the entire cell-contents of many joints of the filaments had become consolidated into a globose or somewhat pear-shaped and smooth spore-like body, which, by expansion in one direction towards one side, eventually burst through the boundary-wall, emerging into the surrounding water by the rupture thus effected. Mr. Crowe informs me that he was not able to trace their ultimate destiny, as they indeed perished before undergoing any further development. It is probable that these bodies, both in the Desmidians to which I have above alluded, as well as the similar productions in the above-mentioned Zygnemaceæ, in each case formed without conjugation, are Gonidia, by which the organisms may be severally propagated.—It may not be out of place to mention here that I have several times noticed in *Closterium lunula* the entire cell-contents transformed into a dense longitudinal series of flask-shaped bodies, with their narrow necks projecting to the outer wall, precisely similar to those figured by Carter ('Annals of Natural History,' 2d series, vol. xvii, p. 114, pl. ix, fig. 9), as occurring in Spirogyra, also by Henfrey ('Quart. Journ. Mic. Sci.,' vol. vii, p. 27, pl. iii, fig. 12), as occurring in his *Chlorosphæra Oliveri*, equivalent, I think, to *Eremosphæra viridis* (*de Bary*); and I imagine also the same as the *unicellular alga* mentioned by Hofmeister in his paper 'On the Reproduction of the Desmidiæ and Diatomeæ,' translated in 'Annals of Natural History' (vol. i, 3d series, p. 1, January, 1858). In my specimens of *Closterium lunula* alluded to, the longitudinal mass of these flask-shaped bodies more than once has suggested to me the hanks of onions as seen hanging up in the market. I have never seen them, however, to produce what Professor Henfrey considered the spermatozoids in his Chlorosphæra, which plant, as I have before elsewhere stated ('Natural History Review,' vol. v, p. 258), though then without knowing that De Bary and Henfrey had named it, is of common occurrence in our district.—Another curious growth in the interior of *Closterium lunula* I would just notice. I refer to the production, within the otherwise empty frond, of a slender jointed filament, contorted and twisted in every direction, and occasionally inosculating; the joints without any apparent contents, save a very few green granules, scattered at considerable intervals. This I should imagine a

parasitic growth, possibly at the expense of the original cell-contents, though it is questionable how the germ could find an entrance into the apparently uninjured cell. Such I also thought the flask-shaped bodies above-mentioned, until I met with Professor Henfrey's remarks on the phenomenon in Chlorosphæra, nor does it quite appear that his conjecture is altogether proven.

Before attempting, in a measure, to account for the above described curious external aberrations from the normal form, it will, I think, be well briefly to draw attention to the mode of division in this family of Desmidiaceæ. So far as I can make out, there can be little doubt that in these plants the first step in the process of division is the formation of a septum at the central space or isthmus, whereupon the segments become gradually removed more distant from each other by the growth of a new cell-wall being interposed between them, eventually forming two new segments. At first the new growth is simple in outline, and pale in colour, but afterwards assumes the characteristic, more or less complex form and degree of tint of the species, and becomes filled with endochrome, exactly similar to the older segments; in the free species separation taking place, each older segment bearing with it a new one, to replace that from which it has been separated by the above-mentioned process of growth. According to Hofmeister (*loc. cit.*), "the new halves are at first lined only by the protruded portions of the pellicle of the contents belonging to the older half cells," and "it is the margin of the half shells which constitute the rings evident in many species, *e.g.* Closterium, Docidium," &c. I believe that the portion of each new segment first formed to be the end-lobe, beneath which, at each side, are then gradually evolved the lateral lobes. Nor can it be that certain specimens in Micrasterias and Euastrum, occasionally met with, are more than an apparent exception to this, in which the end-lobe is not only seemingly absent, but in which, in its place, a more or less deep *sinus* exists. For I should think the phenomenon referred to is due to the arrest of growth of the end-lobe, and which, not keeping pace with the expansion of the lateral lobes, is left behind, thus producing the sinus.

I would here like to remark, parenthetically, that I do not find that Hofmeister, in his paper alluded to, makes any reference to the circumstance of there being, occasionally at least, cast off, immediately after division, from each of the new segments a loose transparent coat, sometimes looking almost like two empty segments, with their ends towards each other, or back to back. What I refer to is well shown by Mrs.

Herbert Thomas (*loc. cit.*, plate v, figs. 13 and 21) in the object of her study, *Cosmarium margaritiferum* and *C. Thwaitesii*. I have seen similar in other species, especially smooth ones, such as *Cosmarium Ralfsii*, *Cosmarium undulatum*, &c. It does not appear to me evident what this pellicle-like production may be. It seems to me to be *possibly* only, as it were, the matrix of gelatine formed during the act of division and fresh growth, which may have become denser and firmer, and from which the fronds then emerging and leaving it behind, gives rise to a membranous appearance with the doubly cup-shaped outline; or it may possibly be a secretion deposited superficially during growth, even more comparable than the usual gelatinous investment to what in the higher plants is called "cuticle," and which in them is occasionally separable by peculiar treatment. In the growing Desmidians referred to, however, this investing pellicle-like production does not extend beyond the new segments, ceasing at the sutures. It is sometimes particularly remarkable in Docidium (in *D. clavatum* I have noticed it), because it forms two lengthened tubes (each, indeed, as long as one of the new segments, and closely applied thereto), in apposition at the closed ends and open at the opposite, from out of which the fronds are to emerge, and indistinguishable till the process has commenced. This may be witnessed under the microscope during its accomplishment, when it is seen that near the open ends the cast-off tube is of a slightly undulated outline; being, in fact, a cast from the new segments. In this species the segments appear to me to possess one or two slight basal inflations, though described as with only one in 'British Desmidieæ.' I believe it, however, to be quite distinct from *D. Ehrenbergii*. Whether a hyaline pellicle-like investment, sometimes met with, entirely surrounding certain single individuals, and apparently like a loose tunic, is anything analogous to the above-mentioned production, I cannot pretend to say; but I have occasionally seen such in some species,—for example, *Euastrum didelta*. This involving cyst does not follow the boundary of the form, but is of a rounded or oval outline, and generally, when I have noticed it, the contained frond seemed to have lost vitality, the endochrome being brownish. What I allude to is not to be mistaken for the gelatinous investment surrounding the frond in so many Desmidian species, being altogether different from anything of the sort seen in fresh specimens. Possibly, like the former, it may be due to its consolidation—here producing, by a process of superficial condensation, as it were, a kind of skin, from beneath which the intervening gelatinous substance has

been absorbed. I hazard such a conjecture the more, because something very like this seems actually to occur in some species of Glœocapsa, or allied forms, in which the concentric gelatinous layers seem to harden into so many frangible investments.

In the foregoing very brief account of the mode of cell-division which occurs in this family, it will be noticed that I look upon the formation of a septum at the isthmus as the preliminary or initial step in the process. Now it appears to me that the accompanying figures represent individuals, which, having taken on them the vegetative growth, or effort to repeat themselves by transverse division, through some inexplicable cause have omitted the formation of a septum. This not having taken place simultaneously with the vegetative activity being aroused, which, being in full energy, the frond in each case proceeded to the development of new growth, which, according to the law which prevails in this family, took place, as usual, between the older segments. In consequence, therefore, the resulting formation consisted of but one cavity, and fresh endochrome being added, they each became entirely filled. Nor do I think some instances lately under observation, and to which I will just allude, are a contradiction to this. Specimens of *Penium cylindrus*, to all appearance perfectly healthy, and manifestly undergoing growth, lately occurred to me; of these, a few individuals presented themselves, in which various stages of the new growth, produced in the usual manner in this species on a line with the older segments, had been accomplished, in some cases the fronds having attained to double the ordinary length—but in none of the instances referred to was any appearance of a septum evident. That the fronds had added to their length by recent new growth was proved by its usual colourless cell-wall, as compared with the red-tinted older segments. That there was no septum was proved by the granular particles partaking of a circulatory motion at and past the central point; and indeed, when present, it is readily seen as a transverse line. No further alteration took place in these specimens kept for some time on a slide. Notwithstanding their not very unusual appearance, for the absence of the central septum was not very striking, and might not be noticed at first sight, unless closely looked into, as well as there being no external aberration in form, it appears to me that the specimens of *Penium cylindrus* alluded to were so many illustrations of the same abnormal mode of growth, extreme cases of which I have tried to depict in the drawings. For I cannot easily understand, without the original separation of the primordial

utricle with the contents, and the formation round it at the ends of new cell-wall, how an articulation could exist to allow of the ultimate separation into two fronds of the old segments with the portion that should appertain to each of the newly-grown structure.

What causes the change in the direction of the axis of growth in the specimens represented by some of the figures, does not appear to me so readily to be accounted for. In each case I should suppose the plant would cease to grow, and the abnormal individual perish, unless, indeed, each or any might be supposed to possess the power of afterwards forming a septum at the suture connecting the newly-grown portion with the older segments, a second new growth becoming then interposed, and the central misshapen structure thus becoming eliminated.

On some of the RARER *or* UNDESCRIBED SPECIES *of* DIATOMACEÆ. Part II. By T. BRIGHTWELL, F.L.S.

16. *Actinocyclus areolatus.*—Valve with a single spine or projection on the upper margin of each area of the disc. Varies in size from ·023 to ·043. (Plate V, fig. 1*a*, 1*b*.) The latter an assumed diagram of a front view.

Omphalopelta areolata, Ehr.—In shell cleanings and guano not unfrequent.

Closely allied to *A. undulatus*.—Mr. T. West says the spines or projections are often seen on alternate areas of the disc only.

17. *Actinocyclus trilingulatus.*—Valves very convex, divided into six segments, alternately elevated and depressed. The elevated segments gradually rise from the circumference to near the centre, where they are rounded off; each alternate segment has a sub-marginal row of dots, or truncated processes. Surface delicately punctato-striate, ·035 to ·073.

(Pl. V, fig. 2; 2*a*, front view; 2*b*, front view, in self-division.) Of this large and beautiful species a few specimens have been found in shell cleanings, West Indies.

18. *Actinocyclus spinosus*, n. sp.—Convex, valves of six segments, alternately slightly elevated and depressed; a few

spines are occasionally detected in the margin; each segment with one or two elevated processes; umbilicate, with the surfaces of the valve, except the umbilicus, punctate. Diameter ·064 to ·077. Shell cleanings.

19. *Actinophœnia splendens*, Shadbolt.—Valve with two plates, one with very fine oblique markings, the other with much coarser markings, arranged in a somewhat pinnate manner. (Pl. VI, fig. 15.)

A common species, varying greatly in size and number of segments. Brick fields, Caermarthen, Mr. Okeden. Very fine.

Syn.—*Actinocyclus octodenarius*, and numerous other species of Ehrenberg:—*Actinocyclus duodenarius, sedenarius, octodenarius. Actinocyclus sedenarius*, Roper ('Micr. Journ.,' vol. ii, pl. VI, fig. 2).—Mr. Roper's figure is unsatisfactory, giving only the fine markings. (Smith, 'Syn. Brit. Diat.,' vol. ii, Appendix, p. 86.) Professor Smith has published, with doubts as to their distinctness, the three species named above, which are certainly only varieties. It is unfortunate that he should have transferred these names from the genus *Actinoptychus*, in which they were placed by Ehr., to that of *Actinocyclus*, creating thus the greatest confusion. Ehrenberg's *Actinoptychus duodenarius, sedenarius, bioctodenarius*, we believe to be totally different from the form in question.

20. *Actinoptychus interpunctatus*, n. sp.—Valves with an indefinite number of double rays, running from the centre to near the circumference, the rays composed of short broken lines, the interstices between the pairs of rays filled up with minute puncta, or dots. (Pl. VI, fig. 17.)

Hab. West Indies; Monterey; New Zealand.

Not an uncommon marine species, from various localities, and allied to *Eupodiscus Ralfsii* and *Eup. sparsus*.

The true species of this and the preceding genus we believe to be few, while Ehrenberg, falling into the extraordinary error of viewing every variety in the number of rays or septa as a species, has made a fresh nomenclature and a new description of nearly all the species necessary.

21. *Asterolampra Marylandica*.—A variety with six segments, the normal number being eight. (Pl. V, fig. 3.)

22. *Aulacodiscus sculptus* (*Eupodiscus sculptus*), Smith.—(Pl. V, fig. 5, a front view.)

Not often seen; and not before figured in this aspect, to our knowledge.

23. *Aulacodiscus radiatus*, Bailey. — This is the true *Eupodiscus radiatus* of the late Professor Bailey, as ascertained by authentic specimens. (See Mr. Roper's remarks in 'Micro. Journ.,' vol. xix, pp. 19 and 262.) (Pl. V, fig. 10*a*, side view; *b*, diagram of front view.)

24. *Aulacodiscus lævis*.—A variety with eight, instead of four processes. Allied to *Scaber*, but differs in the surface, being perfectly smooth. (Pl. VI, fig. 13.)

25. *Hyalodiscus cervinus*, n. sp.—Valve, with exceedingly minute puncta, or dots, scattered over the whole surface; centre, convex; valves, fawn coloured. Diameter, ·054 to ·085. (Pl. V, fig. 9.) Arctic regions, Dr. Sutherland. Shell cleanings, West Indies. Not uncommon.

The peculiar lines mentioned by Bailey in his description of *H. subtilis*, as characteristic of that species, cannot be detected in this, which, in other respects, agrees with it. Mr. T. West says, with the greatest care and best sight, he cannot detect these lines.

26. *Craspedodiscus pyxidicula*, Ehr.—Diameter of the valve, ·049; of the inner punctate portion, ·021. (Pl. V, fig. 4.) Guano, South America.

We take this to be the species referred to. The central third part of the valve is slightly punctate, the puncta diminishing till they almost disappear in the centre. The residue of the valve with regular hexagonal reticulations.

27. *Craspedodiscus marginatus*, n. sp.—Valve, with a broad impunctate margin, having about twenty rays, terminating outwardly in small semicircles; residue of the valve minutely punctate. Diameter, ·037. (Pl. V, fig. 7.) Barbadoes earth.

28. *Craspedodiscus semiplanus*, n. sp.—Margin very broad, with faint radii and puncta. One-half of central part of the valve smooth, the remainder with four or five radii. Diameter, ·024 to ·035. (Pl. VI, fig. 12.) Barbadoes earth.

The margin is sometimes found impunctate.

29. *Craspedodiscus coronatus*, n. sp.—Centre of the valve a small circle, enclosed by a rim of large square puncta, and having within smaller puncta, diminishing in size towards the central point. Outer portion of the valve minutely punctate. Diameter, ·022 to ·068. (Pl. V, fig. 6.) Barbadoes earth.

This very beautiful species has occurred occasionally, but only in a broken state.

30. *Cyclotella stylorum*, n. sp.—Valve with the central circle punctate, and with styliform rays diverging from it, each ending near the margin in a large circular head. Diameter, ·019 to 0·3, the former the common size. (Pl. VI, fig. 16*a*, side view; *b*, front view.) River Rohelle, Sierra Leone. Common.

31. *Cyclotella radiata*, n. sp.—Valve, end view, with simple, strongly-marked radii, about 14 in ·001. Front view, with the ends of the radii appearing as puncta. Diameter, ·018 to ·023. (Pl. VI, fig. 11*a*, end view; *b*, front view.) Shell cleanings, West Indies.

As many as ten frustules have been found in union, leaving it doubtful whether this may not belong to the next genus.

32. *Orthosira oceanica* (*Endictya oceanica*), Ehr.—Diameter, ·027 to ·035. (Pl. VI, fig. 16*a*, end view; *b*, front view.) Common in various gatherings, but not yet recognised as British, unless the valve figured by Dr. Gregory (Clyde Diat., pl. ii, fig. 47) be this form, which appears probable. A large and coarse species: it is seldom that more than two or three valves are found united, and these are not of the same frustules, so that the union by the connecting membrane would seem to be the strongest.

33. *Stephanogonia polygona*, Ehr.—Valve, with central portion impunctate and much elevated, united to the margin by an indefinite number of rays, the spaces between which are sometimes found to be very faintly punctate. Diameter, ·015 to ·025. (Pl. V, fig. 8*a*, side view; *b*, front view.)

Richmond Earth, Virginia, N. A. Common.

From the peculiar form of this interesting species, it happens that it is seldom seen in any but an oblique position.

TRANSLATIONS.

THE MYCETOZOA.—*A contribution towards the knowledge of the lowest Animals.* By Dr. ANTON DE BARY.

DR. DE BARY'S object in the above paper, is to prove that the tribe of organisms, heretofore brought together under the general name of Myxogastric fungi, are not fungi; that they are, in fact, not vegetables, but animals. The author does not undertake, at present, to fix exactly their systematic position, but he assigns them a place provisionally, between the Rhizopods and the Gregarinæ. Should his views be ultimately established, the Zoologists will (as M. Tulasne has remarked), thereby receive compensation in respect of the Corallines, which the botanists have appropriated; but we cannot help thinking, that a great deal more evidence will be required, and much more discussion will have to be gone through, before botanists will be content to assent to the transfer of the Myxogastric fungi to the animal kingdom.

Dr. De Bary's paper is of great length, and we may add, of great interest, but want of space forbids us from attempting anything like a complete analysis of it. At the same time, so far as regards the arguments in favour of the animal nature of the creatures in question, it will be quite possible, in a short space, to give a summary of the author's contention. To those readers of the 'Microscopical Journal' who are altogether unacquainted with the Myxogasteres, we should strongly recommend a careful perusal of the entire paper, premising that such perusal would be much facilitated by a previous reference to Mr. Berkeley's excellent remarks upon the subject in his introduction to Cryptogamic Botany.

Dr. De Bary divides his paper into six chapters, or parts. The first of these contains some general remarks upon the structure of the tissue, and on the fructification in fungi; and the second, an account of the peculiar characteristics of a certain number of the more important genera into which the Myxogasteres have been divided, such genera having been founded principally upon the structure of the ripe spore-cases. In speaking of the elaters or spiral threads in the genus

Trichia, the author observes, that the only correct account of their structure is that given in this Journal in October, 1854, and April, 1857.

In the third part, an account is given of the formation and development of *Æthalium septicum*, and one of the principal arguments in favour of the animal nature of the Myxogasteres is grounded upon the supposed fact that the creeping threads of mucilaginous matter, by the confluence of which the fructifying mass of Æthalium is formed, consist of *sarcode*. The author says—"The main substance of the threads is formed "of that structureless, colourless, transparent, half-fluid "matter, called by Dujardin, *sarcode*, and by Ecken, *shapeless* "*contractile matter*.

"The principal peculiarity of *sarcode*, viz., its high degree "of independent contractility, is very remarkable in the sub- "stance of these threads. It exhibits continual changes of "form and fluctuating motions, such as are known to occur "in the bodies of the Rhizopoda.

"Its chemical nature also agrees essentially with the sar- "code of the lower animals. The rose-red colour produced "by sugar and sulphuric acid, and by Millon's test, and "the brown colour produced by iodine, testify to its nitro- "genous nature. It contracts and hardens in alcohol and in "nitric acid, and becomes pale and transparent in acetic acid, "without however becoming dissolved. On the other hand, "it dissolves in liquor ammoniæ, in solution of caustic potass, "even when very weak, and in solution of carbonate of "potass."

The spore-cases of all Mycetozoa are stated to be formed of sarcode threads, essentially like those of *Æthalium*. Dr. de Bary has noticed in *Æthalium septicum*, as well as in *Didymium serpula*, and in a species of *Physarum* that when the moisture is allowed to evaporate very slowly, and especially at a low temperature, the threads break up, by contraction, into irregularly shaped bodies, which, as the desiccation continues, assume a waxy or horny consistence. The whole substance of each of these bodies again suddenly breaks up into numberless globular or oval cells, surrounded by a double-outlined membrane, which exhibits, under iodine and sulphuric acid, or under Schulze's solution, active and intense cellulose reaction. All these cells in a mass are imbedded in a homogeneous hyaline substance not exhibiting cellulose reaction. This substance is more strongly developed at the outer surface of the mass of cells. It softens in water, so that the cells can be separated by pressure, and then surrounded by a thin layer of the inter-

cellular substance. These waxy bodies change back again into the ordinary sarcode threads under heat and moisture, and Dr. De Bary considers that, by passing into this waxy cellular state, the sarcode threads are enabled to retain their vitality during dry hot weather, and through the winter.

In speaking of the ordinary spore-formation, the author states that the formation of spores in the Mycetozoa always takes place by division of the plasma around previously-formed nuclei, and never directly from the threads of the capillitium. He alleges that Berkeley's observations on *Enerthenema* are incorrect, and doubts also the accuracy of the latter's account of the structure in *Badhamia;* admitting, however, that he (Dr. De Bary) is not acquainted with the latter genus.

The history which is given of the germination of the spores of the Myxomycetes is of considerable interest, and has been confirmed to some extent by the observations of Hoffmann in the 'Botanische Zeitung,' for June 17, 1859. When placed in water, and protected from evaporation, the membrane of the spore opens, and its contents escape in the form of a cell, clothed only by a very thin primordial utricle, thus resembling the reproductive cells of many algæ. These escaped cells undergo changes of form, eventually exhibiting one or two cilia, and two or three vacuoles, of which one at least always pulsates. They have also a motion of progression and rotation, as in the case of ordinary zoospores.

After a few days, bodies appear, differing from the zoospores in their larger size, the greater number and irregular disposition of the vacuoles, the want of cilia, and of oscillating and rotating movements, and by the protrusion of parts of the body, precisely as in the Amæbæ; like which they have also a creeping motion, and are perpetually changing their form. The author states that these singular bodies are not independent productions, but that they are produced from the zoospores, and that by the further development of them, the spore-cases are eventually formed. He says—

"If, therefore, on the one hand, the development of *Amœbæ* from the products of the germination of the spores, and, on the other, the production of the sporangia from the sarcode-threads, which, as regards structure and movements, might be described as colossal filamentary *Amœbæ*, be established, it is an obvious conclusion that the latter arise from the farther development of these *Amœbæ*. And this has been confirmed by direct observation in *Æthalium septicum*, *Lycogala*, and *Stemonitis obtusata* . . . . . Direct develop-

ment of the fructifying threads from the Amœbæ, produced by the growth of the zoospores, appears to me beyond a doubt. And, in accordance with this assumption, is the fact of the frequent occurrence of common Amœbæ (*radiosa, verrucosa*, Ehr.) in tan, rotten wood, &c., the habitats of the Mycetozoa. It remains doubtful, however, whether the sarcode-threads, which directly form the spore-cases, are the product of a single Amœba, or arise from the confluence of several."

Dr. De Bary lays some stress upon the fact that the Mycetozoa, when in the amœboid condition, exhibit in the substance of their bodies (like the aquatic *Amœbæ*) solid matter taken in from without, such as cells of algæ, spores of fungi, &c. He says that if these "*ingesta*" can be considered to be *food*, the fact would establish the animal nature of the Mycetozoa, because, if an organism *eats*, it must be an animal. He admits, however, that there is no proof that the *ingesta* are *food*, and that there is nothing to show that they may not find their way accidentally into the bodies of *Amœbæ*, as Dujardin has suggested. Considering, however, that the movements of the *Amœbæ* resemble those of *Actinophrys*, and that the movements of *Actinophrys* are certainly made in quest of food, the author considers it probable that the aquatic *Amœbæ* and the amœboid Mycetozoa do really eat.

After noticing the affinity of the Mycetozoa with the Siphoneæ and Saprolegnieæ, especially with *Pythium* amongst the latter, Dr. De Bary says—

"But, notwithstanding all these analogies, and even assuming that the vegetable protoplasm in its composition and movements is closely allied to sarcode; assuming also, that many plants, whilst in the condition of zoospores, have the capacity of spontaneous locomotion, and are also contractile; assuming also, that the difference in the movements of the Mycetozoa and of divers plants is only quantitative; nevertheless, free motion exists in the Mycetozoa with an intensity and duration unequalled in any plant . . . . . We should be content to leave the Mycetozoa in the vegetable kingdom if nothing analogous to them could be found amongst animals. But, inasmuch as their structure, their mode of life, their motion from the time of the appearance of the zoospores accord most fully with those of certain animals; inasmuch also as the perfect sarcode-threads hardly differ, except in size, from the sarcode-threads of the Rhizopoda, the result is that the '*Myxomycetes*' must take their place as '*Mycetozoa*' in the animal kingdom."

In the above remarks, we have given what we believe to be

a full and fair account of Dr. De Bary's argument in support of his proposition. We have not time or space to dwell at any length upon the weak parts of his case. One or two points, however, may be mentioned. The fact of the formative threads containing sarcode would not go far to prove their animal nature. Sarcode and vegetable protoplasm are admitted to be nearly allied; and the author himself brings forward the fact of our imperfect knowledge of the chemical natnre of sarcode, by way of explanation of an unexpected chemical reaction which he found in the sarcode-threads. (See p. 125.) We would further observe that his views of spore-formation in the Myxomycetes generally, are in direct opposition to those of Berkeley, Corda, and Tulasne.

The careful conclusions of so eminent an observer as Mr. Berkeley cannot be set aside by a mere allegation of their inaccuracy, as has been done by Dr. De Bary in the instance of *Enerthenema*. In *Badhamia*, again, in which Dr. De Bary throws doubts upon Mr. Berkeley's opinions, we can state from our own observation, that the spores are certainly not formed in the manner described by the author as occurring in the other Myxogastric genera; and Mr. Berkeley's observations, if correct (which we see no reason to doubt), would almost suffice to upset Dr. De Bary's theory; for if it be once admitted that *Badhamia* is truly fungoid, no doubt could exist as to the nature of the rest of the Myxomycetes. With regard to the development of the amæboid bodies out of the zoospores, we may call attention to a paper written a few years since by Dr. Hartig (an abstract of which was given in a former volume of this journal), containing the result of some observations on the Phytozoa of the Antheridia of Marchantia, tending to show that those Phytozoa become ultimately transformed into Amæbæ. The inference from the latter observations would be that Dr. Hartig's amæbæ were vegetables; for if they were really formed from the substance of the Phytozoa, they must necessarily partake of the nature of the latter. On the other hand, Dr. De Bary, assuming the animal nature of Amæbæ generally, and finding Amæbæ produced from the spores of the Myxogasteres, draws the conclusion that the Myxogasteres are animals. Whatever may be the result of the discussion which Dr. De Bary has originated, good service will be done to science if it should lead, as we hope it may do, to a careful and accurate investigation, both by botanists and zoologists, of what we think we may still call the Myxogastric fungi.

NOTES AND CORRESPONDENCE.

On the Universal Screw—The remarks of Mr. Brooke, appended to my paper on the universal screw, which was published in a previous number of the 'Journal,' are so entirely at variance with my own experience, that I venture to give somewhat of an answer to each of his paragraphs, excepting the first, which is merely introductory.

In the first place, then, no workman, be he ever so "practised," can cut up a screw-tool *by hand*, that, as an exact counterpart of the "hob," shall be equal to one made by a screw-cutting lathe; and there are plenty of shops in London and other places where screw-tools can be properly cut up, by comparatively inexperienced workmen.

"The practical difficulties" next mentioned by Mr. Brooke are entirely illusive. If the method of gauging the tops of the threads were sufficient, nothing would be easier than to make both inside and outside screws fit easily and pleasantly in the gauges, and they would screw together in a similar manner; the variations which really occur in the screws made by different makers, to cylindrical gauges of the same size, are at the bottom and sides of the threads.

Mr. Brooke, in the next paragraph, states, that "the bottom of the outside screw can be most easily gauged;" but I am convinced that he cannot have tried it; for he goes on to say, that if screws "enter easily and pleasantly," they must "necessarily" differ in size some "two or three thousandths of an inch," whereas Mr. Whitworth has shown that a variation of one ten-thousandth of an inch is most distinctly perceptible.

The reason why the adjustible screw-cutting gauge possesses an "immunity from the same wear as that to which the screw-tool is liable," is because it has so very little to do. The screw-tool cuts up the whole depth of the thread, the cutting-gauge only removes that which is left by the *wear* of the screw-tool.

I think many persons will find it difficult to understand Mr. Brookes's next paragraph, and the only explanation I

can give is this: The "gauge-taps" issued by the Microscopical Society are slightly taper and differing in size, consequently, when they are sent out to the makers, there are directions with them, as to how far each one is to screw up the nose-piece of the microscope, and that if the screw is made only ·125 in length, it may prevent some of the taps from screwing up as far as they should. On my own part, I see no objection (if proper means be employed) to the maker cutting the screw in whichever way he pleases. I perfectly well remember pointing out to Mr. Brooke the assistance it would be to the workman when cutting the inside screw *by hand*, to make it a greater length than ·125, but, if the work be done in a *machine*, this difficulty ceases; and it is important to save the wear of the screw-tool as much as possible.

And now, in conclusion, may I also tell what I know as to how "the plan recommended by the Microscopical Society has been found to work well amongst those who have adopted it." Of the three houses besides our own who are using the "universal screw," one has ordered a set of the cutting-gauges. Another firm are making their outside screw considerably smaller than Whitworth's gauge, and their inside screw to the Society's tap. The other firm are also using the Society's tap, but they are making their outside screws considerably larger at the bottom than Whitworth's gauge, and it is this firm, so far as I can ascertain, who have altered the nose-pieces of our microscopes, but, in one instance which has come to my knowledge, after having made the alteration, an object-glass which they sent subsequently, proved too large, and would not screw into the microscope at all.—RICHARD BECK, Upper Holloway.

Harrison on a new Pleurosigma. — Somewhat better than twelve months ago I was visiting a friend in Lincolnshire (W. Parker, Esq., of Thornton House), and he showed me a slide containing a few frustules of a Pleurosigma which I had not before seen; I enquired where he had obtained them, and he went with me to the drain (a run of fresh water), but we could not find any at that time, I was paying another visit, to the same friend, about three weeks ago, and we procured a pretty good gathering of them, and as I could not find any account of it in any previous work, I have named it *Pleurosigma Parkerii*. It is about the same size as the *P. fasciola*, but broader in proportion to the length, and the ends not so much contracted.

Length ·0040″ to ·0045″ of an inch; striæ 50 to 55 in ·001.″

I enclose a drawing magnified 400 diameters.

Pleurosigma Parkerii.

Valve broadly lanceolate, acute extremities produced, flexure considerable; colour pale yellow. Length of valve ·0038″ to ·0040″; transverse striæ ·0060″, and stronger than the longitudinal. Fresh water. Thornton-le-Moor, Lincolnshire, Mr. W. Parker.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *Nov. 9th*, 1859.

Dr. Lankester, President, in the chair.

John Stainton, Esq., Longbridge, near Warwick; M. Foster, jun., Esq., Huntingdon; J. Burge, Esq., Fulham; J. L. Bennett, Esq., Pentonville-road; Thos. Hunt, Esq., 23, Alfred-place, Bedford-square; and Jas. Smith, Esq., Soley Terrace, Pentonville, were balloted for and duly elected members of the Society.

Two papers were read—one by Dr. Greville, 'On *Campylodiscus*' ('Trans.' p. 29); the other, 'On Diatomaceæ from the Ohio,' by Professor Hamilton Smith ('Trans.' p. 33).

Mr. Lobb said—It is with much pleasure I bring before the notice of the meeting the latest production of Messrs Powell and Lealand; and we are all of us aware how backward our friends are to make public their own doings. It is a new achromatic condenser of 170° aperture, having, as in the old one, three combinations, so arranged as to be used separately when required. The diaphragm has eleven apertures, and there are three stops and two semicircles. The stops and semicircles can be placed in any portion of the field, so as to produce the best definition. The movements of the diaphragm and stops are so contrived as to be adjusted with the greatest ease and freedom, and not, as in all former condensers, placed so as to give the manipulator the greatest trouble to effect the desired end. One thing is required when using this condenser with the full aperture—viz., to have the objects mounted *on*, as well as *covered over* with, thin glass; and I think if our object-mounters were to mount all objects in this way on mahogany slides; it would be far better, and they would be less liable to break than those mounted on glass slides. The delicate markings of the Diatomaceæ are beautifully defined with this new condenser, using the $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{16}$ object-glasses; the markings on the Amician test are made as fully apparent as are those of the *Hippocampus*; and the delicate lines of *P.*

Acus are easily defined. The price of the condenser is eight guineas, being only one guinea more than the old one of 100° aperture.

I have also to bring before the notice of the meeting, a method which I have some time adopted for showing the phenomena of the rings round the optic axes of crystals, and which is chiefly my own invention. Mr. Woodward, the author of a treatise on polarised light—Professor Potter, of the London University—and Mr. Darkin, of Lambeth, have all seen it; and all agree that they have never seen the phenomena so beautifully displayed. It consists—

1. Of an eye-piece with lenses about the depth of those usually put in the third eye-piece. There is no diaphragm between the lenses, which are so adjusted that the field-lens may be brought nearer to, or farther from, the eye-lens, as occasion may require, thus giving different powers and different fields; and when adjusted for the largest field it will be full fifteen inches, and take in the widest separation of the axes of the arragonite;

2. A crystal stage to receive the crystals, and of the usual construction, into which is screwed a blue tourmaline;

3. A large Nichol's prism as a polariser;

4. A common single double convex three or four-inch lens, set in the middle of a brass tube, long enough, when screwed into the body of the microscope, to reach the polariser, so that all extraneous light may be excluded. At the bottom of this tube there is a blue glass, for the purpose of giving white light when a lamp is used. The concave mirror should be used with a bull's-eye condenser by lamplight; the condenser may be dispensed with by daylight. Messrs. Powell and Lealand are well acquainted with the above apparatus.

The crystals best adapted to show the phenomena of rings round the optic axes are—

Quartz, a uni-axial crystal, one system of rings, no entire cross of black, only the ends of it, the centre being coloured; and as the tourmaline is revolved, the colour gradually changing into all the varied tints of the spectrum, one colour only displayed at once in the centre;

Quartz, cut so as to show right-handed polarisation;

Quartz, cut so as to show left-handed polarisation—that is, the one shows the same phenomena when the tourmaline is turned to the right, as the other does when turned to the left;

Quartz, cut so as to show straight lines;

Calc Spar, a uni-axial crystal, one system of rings, and a

black cross, which changes into a white cross, on revolving the tourmaline, and the colours of the rings into their complementary colours.

Topaz, a bi-axial crystal, although it has two axes, only exhibits one system of rings with one fringe, owing to the wide separation of the axes; the fringe and colours change on revolving the tourmaline; this is the case in all the crystals;

Borax, a bi-axial crystal, the colours more intense than in topaz, but the rings not so complete, only one set of rings taken in, from the same cause as topaz;

Rochelle Salt, a bi-axial crystal, the colours more widely spread, very beautiful, only one set of rings taken in;

Carbonate of Lead, a bi-axial crystal, axes not much separated, both systems of rings exhibited, far more widely spread than those of nitre;

Nitre, a bi-axial crystal, axes very closely approximated, colours intense and beautiful, the rings are also closely united;

Arragonite, a bi-axial crystal, axes rather widely separated, but both systems of rings exhibited, and decidedly the best crystal for displaying the phenomena of bi-axial crystals.

The field-lens of the eye-piece requires to be brought as close as possible to the eye-lens, to see properly the phenomena in quartz and arragonite; it must be placed at an intermediate distance for viewing topaz, borax, Rochelle salt, and carbonate of lead; it must be drawn out to its fullest extent to view nitre and calc spar.

The powers of the micro-polariscope cannot be better displayed than in the exhibition of the foregoing phenomena; there is nothing more beautiful, and few studies more interesting and enlarging to the mind, than that of light, whether common or polarised, which must be entered upon, if the phenomena are to be understood.

The crystal eye-piece, with an artificial tourmaline as an analyser, will be found very useful for polariscope objects generally. There is some spherical aberration, but the largeness of the field far more than compensates for the same. It does best for those objects that require the two-inch object-glass.

I have brought with me this evening two objects—a flea and an insect named Chalifer. They were mounted by one of the members of this society, Mr. Farmer, of Hornsey; and are remarkable for the clear manner in which the muscles are brought out, as also the striated fibre of the same; and which, at the instigation of our much-esteemed president,

Dr. Lankester, I present to the Society, to be placed in their cabinet of curiosities.

December 14th, 1856.

GEO. BUSK, Esq., in the chair.

Sir William Dennison, Governor of Sydney, Australia; C. J. H. Allen, Esq., 28, Woburn-place; Matthew Marshall, jun., Esq., 12, Lyndhurst-grove, Peckham; Benjamin Standring, Esq., 152, Minories; Thomas Ross, Esq., Featherstone-bridge; and George Andrews, jun., Esq.. 55, Friday-street, were balloted for, and duly elected members of the Society.

Dr. Wallich read a paper 'On Siliceous Organisms' ('Trans.' p. 36).

Mr. Roper read a paper 'On Triceratium' ('Trans.' p. 55).

November 9th, 1859.

The following publications, &c., have been presented to the Microscopical Society since the publication of the last Journal:

PRESENTATIONS.

BOOKS.

	Presented by
Professor Huxley's Oceanic Hydrozoa	Ray Society.
Recreative Science, a Monthly Journal of Intellectual Observations, 5 Nos.	The Editor.
Smithsonian Contributions to Knowledge, Vol. X.	The Society.
Smithsonian Report for 1857	Ditto.
Boston Journal of Natural History	
Proceedings of the American Philosophical Society, Vol. VI.	Ditto.
Canadian Journal of Industry, Science, and Art	Ditto.
Academie Royale de Belgique Bulletins, 1858	Ditto.
Ditto, Annuaire, 1858	Ditto.
Bericht über die Verhandlungen der Botanischen, 1858. F. Cohn	The Author.
The Fauna of Blackheath and its vicinity	The Society.
Reply to the "Statement of the Trustees of the Dudley Observatory." By B. Apthorp Gould, jun.	The Author.
Defence of Dr. Gould by the Scientific Council of the Dudley Observatory	Ditto.
Quarterly Journal of the Geological Society, No. 59	The Society.
On the Nomenclature of the Foraminifera. By W. K. Parker and T. R. Jones, Part 1	The Author.
Journal of the Proceedings of the Linnean Society, Nos. 13 and 14	The Society.
British Journal of Dental Science, Nos. 37 to 40	The Editors.
The Photographic Journal, several Nos.	Ditto.
On the Meterology of England, 1857 to 1859	Jas. Glaisher.
The Institutes of the British Meteorological Society	Ditto.
Reports of the Council of ditto	Ditto.

	Presented by
On the Determination of the Mean Temperature of every Day in the Year, from 1814 to 1856. By J. Glaisher	Jas. Glaisher.
The Meteorological and Physical Effects of the Solar Eclipse of March 15th, 1858. By J. Glaisher	Ditto.
On the Meteorology of Scotland for 1857. By J. Glaisher	Ditto.
Several Meteorological Tables. By J. Glaisher	Ditto.
Quarterly Return of Marriages, Births and Deaths for 1856 and 1857	Ditto.
Notices pour servir à l'etude des Polypiers nageurs ou Pennatulides. J. A. Herklots	The Author.
Musée Royal d'Histoire Naturelle à Leyde	Ditto.
Two Slides of Insects to show the Muscular Striæ.	E. G. Lobb.

December 14th.

On the Nomenclature of the Foraminifera. By W. K. Parker and T. R. Jones. Part 2	The Authors.
Canadian Journal of Industry, Science, and Art. No. 24	The Editor.
The Journal of the Royal Dublin Society. No. 15	The Secretary.
The Quarterly Journal of the Geological Society. No. 60	The Society.
Journal of the Proceedings of the Linnean Society	Ditto.
Photographic Journal. 2 Nos.	The Editor.
Note sur une espèce de Dothidea M. le Pasteur Duby	The Author.

MICROSCOPIC PORTRAITS. *Presented by Geo. Jackson, Esq.*

Professor Quekett.	Charles Woodward.	Andrew Ross.
— Brand.	E. E. Meeres.	

PURCHASES.

Nouvelles suites à Buffon, formant, avec les œuvres de cet auteur, un cours complet d'historei naturelle collection accompagnée de Planches.

Evenings with the Microscope. By P. Gosse.

The following copies of British Museum publications were also presented to the Society:

Catalogue of Lepidopterous Insects.	Part 1. Papilionidæ.
List of Lepidoptera	„ 1 to 3.
„ „	18 Parts.
„ Hymenoptera	2 „
Catalogue „	7 „
List of Diptera	7 „
„ Homoptera	5 „
„ Hemiptera	2 „
„ Coleoptera	9 „
Guide to the Mollusca	1 „
Catalogue of Entozoa	1 „
List of British Animals	17 „
Catalogue of British Hymenoptera	1 „
„ Fossorial Hymenoptera	1 „
„ Marine Polyzoa	2 „

W. G. SEARSON, Curator.

HISTORIC SOCIETY OF LANCASHIRE AND CHESHIRE.

On the Diatomaceæ of the Neighbourhood of Liverpool.

By Thomas Comber, Esq.

(Read 16th December, 1858.)

In laying before the Society the following contribution to the Liverpool Flora, I have been influenced by a wish to increase, in some degree, the knowledge of the Natural History of the neighbourhood, towards which so much has been done by other Liverpool naturalists; and although I have confined myself to a single order I trust the subjoined list will be of some use in this respect. I am also not without hope that it will assist those whose researches have been extended over a wider field than my own, in their investigation into the geography of the order, at present in a very unsatisfactory state.

I have adopted the limits established by Dr. Dickenson in his Flora of Liverpool, extending to the north as far as Southport. In this district there are found as many as 257 described species of Diatomaceæ, affording representatives of 51 genera. Of these 120 are fresh water, 64 brackish, and 73 marine species: these last numbers are, however, only approximate, in consequence of many species being sometimes found in both fresh and brackish, and others in marine and brackish, localities. For instance, I have gathered *Navicula Westii* and *Stauroneis salina*, both generally considered altogether marine species, in a living state in a pool to which no sea water could possibly have got for at least eight months.

Those species usually found in Alpine situations, such as *Navicula crassinervia*, *N. serians*, some of the *Pinnulariæ* and *Odontidia*, *Tabellaria flocculosa*, and several of the *Melosiræ* and *Orthosiræ*, are absent; but this is only what would be expected: another deficiency for which I cannot account occurs in the allied genera of *Podosphenia*, *Rhipidophora* and *Lichmophora*, containing in all ten species, of which the only representative found in this neighbourhood is *R. Dalmatica*

I have used Professor Smith's nomenclature, as being the best known, even in many instances where it is opposed to my own views. Only twenty of the species, discovered since the publication of the second volume of that work, are not described in his synopsis.

My best thanks are tendered to three members of the Microscopic Club of this town, Messrs. G. M. Browne,

T. Sansom and L. Hardman, who have very greatly assisted me; how much, their initials, attached to the localities given on their authority, will show. For the other localities and for the naming of all, I am myself answerable.

EPITHEMIA, Kützing.

E. turgida, Sm.—Frequent. Well at Sefton, August, 1856, and July, 1857; Bidston marsh, October, 1856, and many other localities

E. Zebra, Kütz.—Bidston marsh, October, 1856.

E. Argus, Sm.—Railway bridge at Spital, September, 1858, L. H.—Well in Brombro' wood, September, 1858.

E. alpestris, Sm.—Well at Sefton, August, 1856, and July, 1857; railway bridge at Spital, April, 1857.

E. Sorex, Kütz.—Sefton well, August, 1856, and July, 1857; Bidston marsh, August, 1858, &c.

E. Westermanii, Sm.—Bidston marsh, October, 1856, and October, 1857—Birkdale marsh, G. M. B.

E. rupestris, Sm.—Bridge at Spital, Sept., 1858, L. H., &c.

E. gibba, Kütz.—Frequent. Bidston marsh, Oct., 1856, &c.

E. ventricosa, Kütz.—Railway bridge, Highfield, L. H.

EUNOTIA, Ehrenberg.

E. Arcus, Sm.—Pit at Rock ferry, June, 1856.

CYMBELLA, Agardh

C. Ehrenbergii, Kütz.—River Alt, near Sefton, July, 1857.

C. cuspidata, Kütz.—Always occurs sparingly. Thornback pool, Crosby, September, 1856—Southport, June, 1857, G. M. B.

C. maculata, Kütz.—Patrick's well, Spital, March, 1857.

C. Helvetica, Kütz.—Well at Sefton, July, 1857.

——— ——*Var β.*—Thornback pool, Crosby, Sept. 1856.

AMPHORA, Ehrenberg.

A. ovalis, Kütz.—Frequent. Canal bridge over R. Alt, &c.

A. affinis, Kütz.—Not uncommon. Bidston marsh, July, 1856, and October, 1857, &c.

A. salina, Sm.—Bidston marsh, July, 1856; Great Float, April, 1858.

COCCONEIS, Ehrenberg.

C. Pediculus, Ehr.—Lock at Sefton, July, 1857; stream near Shotwick, Cheshire, June, 1858.

C. Placentula, Ehr.—Very common; in fact in almost all fresh water gatherings.

C. Thwaitesii, Sm.—Rock in Dingle, March, 1857.

C. Scutellum, Ehr.—New Brighton, March, 1857, L. H.

C. eccentrica, Donk.—New Brighton sands, September, 1858.

COSCINODISCUS, Ehrenberg.

C. radiatus, Ehr.—Common. New Brighton in several gatherings, &c.

C. eccentricus, Ehr.—Common. New Brighton, &c.

C. concinnus, Sm.—R. Fender, Bidston marsh, June, 1856; New Brighton, April, 1858—Southport sands, August, 1858, G. M. B.

EUPODISCUS, Ehrenberg.

E. fulvus, Sm.—Bidston marsh, October, 1857.

E. crassus, Sm.—New Brighton—Southport sands, August, 1858, G. M. B.

E. radiatus, Sm.—Southport marsh, June, 1857; New Brighton, April, 1858.

E. Ralfsii, Sm.—Southport marsh, June, 1857; New Brighton, April, 1858.

ACTINOCYCLUS, Ehrenberg.

A. undulatus, Kütz.—Common. New Brighton, &c.

A. duodenarius, *A. sedenarius*, *A. octodenarius*, } New Brighton, April, 1858; Bidston marsh, October, 1857.

TRICERATIUM, Ehrenberg.

T. Favus, Ehr.—New Brighton, April, 1858—Southport sands, August, 1858, G. M. B.

T. undulatum, Ehr.—New Brighton, April, 1858—Southport sands, August, 1858, G. M. B.

CYCLOTELLA, Kützing.

C. Kützingiana, Thw.—Aintree pit, June, 1857; Bidston marsh, August, 1858.

———— *Var* β.—Thornback pool, Crosby, Sept. 1856.

C. operculata, Kütz.—R. Dee, near Queen's ferry, June, 1858.

CAMPYLODISCUS, Ehrenberg.

C costatus, Sm.—R. Alt, Sefton, July, 1857; well in Brombro' wood, May, 1857.

C. spiralis, Sm.—Bidston marsh, October, 1856.

C. cribrosus, Sm.—Bidston marsh, October, 1857.

C. parvulus, Sm.—Head of Wallasey pool, May, 1857; great float, April, 1858.

SURIRELLA, Turp.

S. biseriata, Bréb.—Hoylake, October, 1856, G. M. B.

S. linearis, Sm.—Patrick's well, Spital, March, 1857; pit at Aintree, June, 1857.

S. constricta, Sm.—Bidston marsh, October, 1857.

S. lata, Sm.—New Brighton, September, 1858.

S. splendida, Kütz.—Bidston marsh, October, 1856.
S. striatula, Turp.—Frequent in brackish water. Bidston marsh, &c.
S. Gemma, Ehr.—Primrose hill, New ferry, July, 1856; Bidston marsh, October, 1857.
S. fastuosa, Ehr.—New Brighton, April, 1858.
S. Craticula, Ehr.—Bidston marsh, October, 1856.
S. ovalis, Bréb.—Frequent. Railway bridge, Spital, May, 1857, &c.
S. panduriformis, Sm.—Rock at Storeton, March, 1857.
S. ovata, Kütz.—Common in fresh water.
S. salina, Sm.—Sands at Great Meols, May, 1857.
S pinnata, Sm.—Pit at Rock ferry, March, 1857—Railway bridge, Highfield, L. H.
S. angusta, Kütz.—Rock at Storeton, March, 1857.
S. minuta, Bréb.—Lock at Sefton, July, 1857.
S. Crumena, Bréb.—River Fender, June, 1856; near Wallasey pool, Seacombe, April, 1857; River Alt, July, 1857, &c.

TRYBLIONELLA, Smith.

T. gracilis, Sm.—Not uncommon in brackish water Frequently from Bidston marsh.
——— *Var* β.—Primrose hill, New ferry, July, 1856.
T. marginata, Sm.—Not uncommon in brackish water. Bidston marsh, October, 1857; Seacombe, April, 1858, &c.
T. punctata, Sm,—Primrose hill, New ferry, July, 1856.
T. acuminata, Sm.—Frequent in brackish water. Bidston marsh, &c.

CYMATOPLEURA, Smith.

C. Solea, Sm.—Bidston marsh, Oct. 1856, and Oct. 1857.
C. apiculata, Sm.—Frequently met with, R. Alt, &c.
C elliptica, Sm.—Bidston marsh, October, 1857; R. Alt, July, 1857, &c.

NITZSCHIA, Hassall.

N. sigmoidea, Sm.—Not uncommon. R. Alt at Sefton, July, 1857, &c.
N. Brébissonii, Sm.—Bidston marsh, July, 1856, and Mar. 1856.
N. Sigma, Sm.—Not uncommon in brackish water. Bidston marsh, frequently.
N. linearis, Sm.—Rather common. R. Alt, &c.
N. angularis, Sm.—New Brighton, March, 1857, L. H.
N. Amphioxys, Sm.—Frequent, though generally but few in a gathering. Moss from Rock ferry, October, 1857.
N. minutissima, Sm.—Patrick's well, Spital, March, 1857.
N. vivax, Sm.—Bidston marsh, October, 1857—Birkdale marsh, June, 1857, G. M. B.

N. virgata, Roper.—Sands at Great Meols, May, 1857; New Brighton, September, 1858.

——— Sp. (*Epithemia marina*, Donk.) Sands at New Brighton, September, 1858.

N. dubia, Sm.—Eastham marsh, September, 1858; Skew bridge, Bebington, May, 1856.

N. bilobata, Sm.—Bidston marsh, October, 1857.

N. plana, Sm.—Not uncommon. Bidston marsh, &c.

N. birostrata, Sm.—Eastham marsh, September, 1858.

N. Closterium, Sm.—Not uncommon. Southport sands, August, 1858; Eastham marsh, September, 1858; Bidston marsh on several occasions.

N. Tœnia, Sm.—Southport sands, August, 1858.

AMPHIPRORA, Ehrenberg.

A. alata, Kütz.—Not uncommon in brackish marshes. Eastham marsh, September, 1858, &c.

A. Ralfsii, Arnott.—New Brighton sands, September, 1858.

A. paludosa, Sm.—Near Wallasey pool, Seacombe, April, 1857.

A. duplex, Donk.—New Brighton sands, September, 1858.

A. vitrea, Sm.—Eastham marsh, September, 1858; New Brighton sands, September, 1857.

A. pusilla, Greg.—New Brighton sands, September, 1858.

A. complexa, Greg.—Great Float, April, 1858.

AMPHIPLEURA, Kützing.

A. sigmoidea, Sm.—Great Float, April, 1858—Canning Graving Dock, August, 1857, R. Daw.

NAVICULA, Bory.

N. rhomboides, Ehr.—Bridge at Spital, May, 1857.

N. lanceolata, Kütz.—Bidston marsh, May, 1856.

N. cuspidata, Kütz.—R. Fender, Bidston marsh, June, 1856.

N. Liber, Sm.—Great Float, April, 1858—Canning Graving Dock, August, 1857, R. Daw.

N. firma, Kütz.—Not unfrequent, but always occurs sparingly. Rock in the Dingle, March, 1857, &c.

N. æstiva, Donk.—New Brighton, September, 1858.

N. elliptica, Kütz.—Common.

N. pygmæa, Kütz.—Seacombe, April, 1851; Primrose hill, New ferry, July, 1856.

N. Jennerii, Sm.—Bidston marsh, October, 1857; Seacombe, April, 1858; Southport sands, August, 1858, &c.

N. Westii, Sm.—Seacombe, April, 1858.

N. convexa, Sm.—New Brighton sands, September, 1858.

N. elegans, Sm.—Pretty frequent in brackish water. Wallasey pool, Seacombe, April, 1856; Bidston and Eastham marshes, &c.

N. palpebralis, Bréb.—New Brighton sands, September, 1858.
N. Semen, Kütz.—R. Alt, near Sefton, July, 1857.
N. affinis, Ehr.—Wall on Dingle shore, March, 1857; railway bridge, Spittal, May, 1857.
N. inflata, Kütz.—R. Alt, near Sefton, July, 1857.
N. gibberula, Kütz.—Frequent, but always much mixed with other diatoms.
N. amphirynchus, Ehr.—R. Alt, near Sefton, July, 1857—Storeton, June, 1856, L. H.
——————*Var.* β.—Frequent, generally in brackish water.
N. sphærophora, Kütz.—Hoylake, October, 1856, G. M. B.
N. tumens, Sm.—Bidston marsh, July, 1856; October, 1856; and October, 1857.
N. punctulata, Sm.—Primrose hill, New ferry, July, 1856; Eastham marsh, September, 1858.
N. pusilla, Sm.—Sands at Great Meols, May, 1857; Bidston marsh, October, 1856, and October, 1857.
N. tumida. Sm.—Moss at Rock ferry, October, 1857.
N. dicephala, Kütz.—Birkdale marsh, June, 1858, G. M. B.
N. cryptocephala, Kütz.—Bidston marsh, May, 1857; rock at Storeton, March, 1857, &c.
N. lineata, Donk.—New Brighton sands, September, 1858.
N. didyma, Kütz.—Frequent, Bidston marsh, Oct. 1857, &c.
N. binodis, Ehr.—Thornback pool, Crosby, September, 1856; Hoylake, October, 1856, G. M. B.
N. lævissima, Kütz.—Thornback pool, Crosby, September, 1856—Southport, June, 1857, G. M. B.
N. pectinalis, Bréb.—Sands at Great Meols, May, 1857, R. Fender, Bidston marsh, August, 1858; Dee marsh, near Queen's ferry, June, 1858.
N. retusa, Bréb.—New Brighton sands, September, 1858; Southport sands, August, 1858, G. M. B.
N. Lyra, Ehr.—Seacombe, April, 1858; Southport sands, August, 1858.
N. humerosa, Bréb.—Sands at Great Meols, May, 1857; New Brighton sands, Sept. 1858; Southport marsh, June, 1857.
N. Trochus, Greg.—Hoylake, October, 1856, G. M. B.
N. lacustre, Greg.—River Alt, Sefton, July, 1857.
—————— *var.* β, with var. *a*.
N. quadrangularis, Greg.—New Brighton sands, April, 1858; Leasowe sands, October, 1858; Southport sands, August, 1858, G. M. B. Generally much elongated, with a curved median line.
N. apiculata, Bréb.—Southport sands, August, 1858.

PINNULARIA, Ehrenberg.

P. major, Sm.—Storeton, June, 1856, L. H.

P. viridis, Sm.—Common. Patrick's well, Spital, &c.
P. oblonga, Sm.—Well in Brombro' woods, May, 1857; well at Moreton, Cheshire, May, 1857.
P. distans, Sm.—New Brighton sands, April and Sept. 1858.
P. peregrina, Ehr.—Very common in brackish water.
P. acuta, Sm.—Bidston marsh, October, 1856; Rock ferry, March, 1857.
P. directa, Sm.—New Brighton, October, 1858.
P. radiosa, Sm.—Frequent. Bidston marsh, &c.
P. gracilis, Ehr.—Common in Bidston marsh, and other brackish water localities.
P. viridula, Sm.—Bidston marsh, July, 1856.
P. Cyprinus, Ehr.—Common in many localities subject to marine influence.
P. Johnsonii, Sm. var. β.—Bootle shore, Dec., 1858, G. M. B.
P. stauroneiformis, Sm.—Hoylake, October, 1856, G. M. B. Highfield, L. H.
P. mesolepta, Ehr.—Patrick's well, Spital, March, 1856; well at Moreton, Cheshire, May, 1857, &c.
P. interrupta, Sm.—Storeton, June, 1856, L. H.
——— *var.* β.—Storeton, June, 1856, L. H. Bidston marsh, October, 1856.
P. borealis, Ehr.—Thornback pool, September, 1856; Moss at Rock ferry, October, 1857.
P. integra, Sm.—Not uncommon. Thornback pool, September, 1856; River Alt, near Sefton, July, 1857, &c.

STAURONEIS, Ehrenberg.

S. Phœnicenteron, Ehr.—Not uncommon. Well in Brombro' May, 1857, &c.
S. gracilis, Ehr.—Well at Moreton, May, 1857; Storeton, June, 1856, L. H.
S. acuta, Sm.—Well in Brombro' woods, May, 1857.
S. salina, Sm.—Seacombe, April, 1858.
S. crucicula, Sm.—Wallasey pool, April, 1856; and April, 1857; Southport marsh, June, 1857.
S. anceps, Ehr.—Not uncommon. Rock ferry, March, 1857; well at Moreton, May, 1857, &c.
S. linearis, Ehr.—Thornback pool, Crosby, September, 1856; Moreton well, May, 1847.
S. pulchella, Sm.—New Brighton, September, 1858; Southport sands, August, 1858, G. M. B.
——— *var.* (*Navicula angulata*, Bréb.) New Brighton sands, May, 1859.

PLEUROSIGMA, Smith.

P. rigidum, Sm.—Southport sands, August, 1858, G. M. B.

P. elongatum, Sm.—Bidston marsh, July, 1856, and October, 1857; Southport sands, August, 1858.
P. intermedium, Sm.—Bootle, December, 1858, G. M. B.
P. delicatulum, Sm.—Bidston marsh, May, 1856, L. H.
P. strigosum, Sm.—New Brighton, April, 1858.
P. angulatum, Sm.—Frequent. Bidston marsh, several times; Primrose hill, &c.
P. Æstuarii, Sm.—Southport sands, August, 1858; New Brighton sands, September, 1858.
P. obscurum, Bidston marsh, May, 1856, L. H.
P. Balticum, Sm.—Bidston marsh, October, 1857; Eastham marsh, September, 1858.
P. Wansbeckii, Donk. (*P. Balticum var.* β. Sm.)—Southport sands, August, 1858.
P. strigilis, Sm.—Bidston marsh, October, 1857.
P. acuminatum, Sm —Primrose hill, July, 1856; Bidston marsh, October, 1857.
P. Fasciola, Sm.—Primrose hill, July, 1856; Bidston marsh, October, 1857; Eastham marsh, September, 1858, &c.
P. macrum, Sm.—Bidston marsh, October, 1857.
P. tenuissimum, Sm.—Wallasey pool, near Spital, April, 1858.
P. littorale, Sm.—Primrose hill, July, 1856.
P. Hippocampus, Sm.—Not uncommon. Bidston marsh; Ditton marsh, &c.
P. attenuatum, Sm.—Brook near Shotwick, Cheshire, June, 1858.
P. lacustre, Sm.—Not unfrequent. River Alt, near Sefton, July, 1857, &c.
P. Spencerii, Sm.—Storeton, June, 1856, L.H.; River Fender, June, 1856; Canal bridge over River Alt, June, 1857.
P. lanceolatum, Donk.—New Brighton sands, Sept., 1858.
P. marinum, Donk.—New Brighton sands, September, 1858.

TOXONIDEA, Donkin.

T. Gregoriana, Donk.—Southport sands, Aug. 1858, G. M. B.—Stomach of Noctiluca, Southport, Aug. 1858, T. S.
S. insignis, Donk.—Stomach of Noctiluca, Southport, August, 1858, T. S.

SYNEDRA, Ehrenberg.

S. pulchella, Kütz.—Wallasey pool, April, 1857; Southport marsh, June, 1857.
S. minutissima, Kütz.—"Birkenhead, Cheshire. G. Shadbolt," *Sm. Synops.*
S. radians, Sm.—Almost universally present in fresh-water gatherings.
S Ulna, Ehr.—Common, though not so much so as the last.

S. Oxyrynchus, Kütz.—Bidston marsh, October, 1857.
S. obtusa, Sm.—Thornback pool, Sept., 1856; Moreton well, May, 1857.
S. capitata, Ehr.—Hoylake, October, 1856, G. M. B.—Bidston marsh, October, 1857.
S. tabulata, Kütz.—R. Fender, June, 1856; Dee Marsh, near Queen's ferry, June, 1858.
S. affinis, Kütz.—Bidston marsh, October, 1857.
S. Arcus, Kütz.—Dingle bay, February, 1857; Rock ferry slip, February, 1857, L. H.

COCCONEMA, Ehrenberg.

C. lanceolatum, Ehr.—Frequently. Well in Brombro' woods, May, 1857, &c.
C. cymbiforme, Ehr.—Frequent. Rock in Dingle, March, 1857.
C. Cistula, Ehr.—Canal bridge, over R. Alt, June, 1857.
C. parvum, Sm.—Rock in Dingle, March, 1857.

DORYPHORA, Kützing.

D. Amphiceros, Kütz.—Sparingly in many localities subject to marine influence. New Brighton sands, Sept. 1858.

GOMPHONEMA, Agardh.

G. geminatum, Ag.—Patrick's well, March, 1856, L. H.
G. constrictum, Ehr.—Frequent. Rock ferry, March, 1857, &c.
G. acuminatum, Ehr.—Frequent. Well at Moreton, May, 1857, &c.
G. cristatum, Ralfs.—Canal bridge over R. Alt, June, 1857.
G. dichotomum, Kütz.—Well at Moreton, May, 1857.
G. tenellum, Sm.—Frequent. Rock ferry, March, 1857, &c.
G. capitatum, Ehr.—*Var.* γ. Well at Moreton, May, 1857.
G. olivaceum, Ehr.—Rock ferry, March, 1857.
G. intricatum, Kütz.—Rock in Dingle, March, 1857.
G. curvatum, Kütz.—Frequent. Sefton lock, July, 1857, &c.

RHIPIDOPHORA, Kutzing.

R. Dalmatica, Kütz.—Dingle bay, February, 1857.

MERIDION, Agardh.

M. circulare, Ag.—Not unfrequent, but always much mixed with other diatoms. Near Wallasey pool, Seacombe, April, 1856.

BACILLARIA, Gmel.

B. paradoxa, Gmel. In most brackish localities. Bidston, Eastham, Ditton, and Dee marshes.
B. cursoria, Donkin.*—Sands at New Brighton, Sept. 1858.

* In my specimens the F.V. is always presented to the eye when in the living state. I consequently name it with a little doubt; it is certainly not *B. paradoxa*.

HIMANTIDIUM, Ehrenberg.

H. pectinale, Kütz. Frequent. Well at Storeton, March. 1857, &c.
H. undulatum, Sm.—Well at Storeton, March, 1857.
H. Soleirolii, Kütz.—Well at Storeton, March, 1857.
H. gracile, Ehr.—Rather common. Bidston marsh, May, 1856; rock in Dingle, March, 1857, &c.

ODONTIDIUM, Kützing.

O. mutabile, Sm.—Patrick's well, Spital, March, 1856; Skew bridge, Bebbington, May, 1857; railway bridge, Spital, May, 1857.
O. parasiticum, Sm.—Bidston marsh, October, 1857; in Rivington Pike water supplied to the town.

DENTICULA, Kützing.

D. obtusa, Kütz.—Canal bridge over R. Alt, June, 1857.
D. sinuata, Sm.—Railway bridge, Spital, May, 1857; rock in Dingle, March, 1857; canal bridge over R. Alt, June, 1857.

FRAGILLARIA, Lyngbye.

F. capucina, Desm.—Rock ferry, March, 1857; a curious variety from Bidston marsh, October, 1857.
F. virescens, Ralfs.—Patrick's well, March, 1856.

EUCAMPIA, Ehrenberg.

E. zodiacus, Ehr.—Rock ferry slip, July, 1856—Stomach of Noctiluca, Southport, August, 1858, T. S.

ACHNANTHES, Bory.

A. longipes, Ag.—New Brighton, March, 1857, L. H. Canning Graving Dock, July, 1857, R. Daw.
A. brevipes, Ag.—Common in the Mersey. Rock ferry slip, July, 1856; Dingle Bay, February, 1857, &c.
A. subsessilis, Kütz.—Bidston marsh, May, 1856; July, 1856; and Oct. 1857.
A. exilis, Kütz.—Rock in Dingle, March, 1857; railway bridge, Spital, May, 1857; canal bridge over R. Alt, June, 1857.

ACHNANTHIDIUM, Kützing.

A. lanceolatum, Bréb.—Not uncommon. Rock near Storeton, March, 1857, &c.
A. coarctatum, Bréb.—Skew bridge, Bebbington, May, 1857; moss from Rock ferry, October, 1857.
A. microcephalum, Kütz.—Canal bridge over R. Alt, June, 1857.

RHABDONEMA, Kützing.

A. arcuatum, Kütz.—Woodside slip, May, 1857; New Brighton, February, 1857, L. H.

R. minutum, Kütz.—Dingle bay, February, 1857—Rock ferry slip, February, 1857, L. H.

STRIATELLA, Agardh.

S. unipunctata, Ag.—Primrose hill, New ferry, July, 1856.

DIATOMA, Dec.

D. vulgare, Bory.—Common. Canal near Aintree, June, 1858, &c.

D. elongatum, Ag.—Common. Generally in brackish water.

——— *Var.* β.—Hoylake, October, 1856, G. M. B.

——— *Var.* γ.—Aintree, June, 1857.

GRAMMATOPHORA, Ehrenberg.

G. marina, Kütz.—New Brighton, February, 1857, L. H.—Woodside slip, May, 1857.

G. serpentina, Kütz.—New Brighton, April, 1857.

TABELLARIA, Ehrenberg.

T. fenestrata, Kütz.—Well opposite Bebbington Church, July, 1856.

BIDDULPHIA, Gray.

B. aurita, Bréb.—R. Fender, June, 1856—Southport sands, August, 1858, G. M. B.

B. Rhombus, Sm.—Common. New Brighton, frequently; Leasowe, Southport, and Hoylake.

B. Baileyii, Sm.—New Brighton, April and October, 1858—Stomach of Noctiluca, Southport, August, 1858, T. S.

B. turgida, Sm.—Leasowe, September, 1858, G. M. B.

B. granulata, Rop.—New Brighton, April, 1858—Leastowe September, 1858, G. M. B.

PODOSIRA, Ehrenberg.

P. Montagnei, Kütz.—Common.—Bidston marsh, Southport, &c.

P. maculata, Sm.—Not uncommon. New Brighton, &c.

MELOSIRA, Agardh.

M. nummuloides, Kütz.—Common. R. Mersey, frequently; Dee marsh, near Queen's ferry, June, 1858.

M. Borrerii, Grev.—Bootle shore, December, 1858, G. M. B.

M. varians, Ag.—Extremely common.

M. Westii, Sm.—Bidston marsh, October, 1857.

ORTHOSIRA, Thwaites.

O. marina, Sm.—New Brighton, several times.

O. orichalcea, Sm.—Bidston marsh, October, 1856; well at Sefton, July, 1857; and June, 1858.

MASTOGLOIA, Thwaites.

M. lanceolata, Thw.—Southport marsh, June, 1857; Birkdale marsh, June, 1857, G. M. B.

M. Smithii, Thw.—Birkdale marsh, June, 1857. G. M. B.

ENCYONEMA, Kützing.

E. prostratum, Ralfs.—Sefton lock, July, 1857; canal bridge, over R. Alt, June, 1857.

COLLETONEMA, Brébisson.

C. eximium, Thw.—Bidston marsh, October, 1857.

C. vulgare, Thw.—Storeton well, March, 1857.

C. neglectum, Thw.—R. Alt, near Sefton, July, 1857; R. Fender, Bidston marsh, August, 1858.

SCHIZONEMA, Agardh.

S. cruciger, Sm.—Bidston marsh, May, 1856; New Brighton, February, 1857; Canning Graving Dock, August, 1858.

S. helmintosum, Chauv.—Rock ferry slip, February, 1857, L. H.—Dingle Bay, February, 1857.

S. Smithii, Agardh.—Rock ferry slip, February, 1857—New Brighton, March, 1857, L. H.

S. Grevillii, Agardh.—New Brighton, March, 1857, L. H.; and October, 1856, G. M. B.

HOMŒOCLADIA, Agardh.

H. filiformis, Sm.—Canal bridge over R. Alt, June, 1857—Canal at Aintree, June, 1858, L. H.

H. sigmoidea, Sm.—Pit at Aintree, June, 1857; Bidston marsh, October, 1857.

ASTERIONELLA, Hassall.

A. formosa, Hass.—In Rivington Pike water supplied to the town.

ZOOPHYTOLOGY.

Descriptions of New Species *of* Polyzoa. Collected by George Barlee, Esq., in Shetland.

The assiduous dredging labours of Mr. Barlee, more especially in the Northern seas of Scotland, have, as is well known, been the means of introducing numerous additions to the British Marine Fauna, among which, those belonging to the domain of Zoophytology are by no means the least considerable. Having been favoured by Mr. Barlee with the opportunity of examining the Polyzoa collected by him within the last two years, we here commence the description of the new or imperfectly known species comprised among them. As these are numerous, and our limits, so far as illustrations are concerned, circumscribed, the description of these species will occupy several numbers of the journal, although, in the meanwhile, brief descriptions of most of the new forms were presented to the British Association at its late meeting.

Sub-order. *Cheilostomata.*

Fam. 1. *Flustridæ.*

Gen. 1. *Flustra.* Linn.

1. *F. Barlei*, n. sp. Pl. XXV, fig. 4.

F. polyzoario foliaceo, diviso, lobato; cellulis oblongis, margine simplici; ovicellulis cucullatis; aviculariis intercellulas sparsis, oblique positis, mandibulo semicirculari.

Cells oblong, with a simple margin; ovicells shallow, cucullate; avicularia few, scattered, placed obliquely, and having a semicircular mandible. Polyzoarium foliaceous, divided, lobate.

Hab. Shetland, *Barlee.*

The polyzoarium of this species bears a close resemblance to some conditions of *Flustra foliacea*; but, when examined, it will at once be seen to be wholly distinct from that and all other hitherto described species. The cells are of the same oblong, rectangular shape as those of *F. papyracea* and *F. truncata*, and, as in those species, wholly membranous in front. *F. Barlei* differs, however, from both, in the far larger size of the cells, which is at least double that of the cells in either of the species named. The margin is wholly

unarmed, as in *F. truncata*, from which *F. Barlei*, is however distinguished, not only by the far smaller dimension of the cells, but also by the oblique position of the avicularia, and the widely different habit of its growth. *F. papyracea*, besides its having a small marginal spine on each upper angle, has no avicularia, so far as I am aware, and also differs from *F. Barlei* very widely in habit.

This is an important addition to the British Zoophytological Fauna; and it is curious that so large and well-marked a species should have hitherto escaped recognition.

Fam. 2. *Membraniporidæ.*

Gen. 2. *Membranipora.* Blainv.

1. *M. cornigera*, n. sp. Pl. XXV, fig. 2.

M. incrustans; cellulis pyriformibus, supernè angustatis, margine glabro spinis 6 armato quarum infimis bifurcatis; laminâ subgranulosâ. Aviculariis crebris, inter cellulas sparsis, mandibulo semicirculari instructis.

Incrusting; cells pyriform, contracted above, expanded below, with a smooth margin armed with three pairs of spines, of which the lowest are forked; lamina subgranular. Avicularia numerous, interspersed among the cells, with a rounded or semicircular mandible.

Hab. Shetland, *Barlee.*

When in a state of tolerable preservation, no confusion can be made between this species and any other. Its nearest ally, perhaps, is *M. Flemingii*, in which the form of the cell is pretty nearly the same, and the number of marginal spines equal; but the disposition of the aivcularia differs, so that even in much worn specimens, sufficiently distinct characters may in most cases be perceived. When the marginal spines are uninjured, the peculiar forked form of the lowest pair will at once suffice to distinguish the present from any other British species. In *M. Flemingii* also, the mandible of the avicularium is acutely pointed, whilst in *M. cornigera* it is rounded and obtuse.

M. vulnerata, n. sp. Pl. XXV, fig. 3.

M. incrustans; cellulis subpyriformibus seu ovalibus, supernè angustatis; aperturâ parvâ, semicirculariâ; laminâ granulosâ, utrinque fissurâ sigmoideâ plerumque ornatâ; margine granulosâ, inermi; vibraculis intercellulas sparsis.

Incrusting; cells subpyriform or suboval; aperture small, semicircular lamina granular, usually with a narrow sigmoid slit on either side; margin granular, unarmed. Vibracula scattered among the cells.

Hab. Shetland, *Barlee;* on stone.

This, so far as I am aware, is the only *Membranipora* furnished with vibracular instead of avicularian organs.

3. *M. minax*, n. sp. Pl. XXV, fig. 1.

M. adnata; cellulis pyriformibus infernè angustatis; aream ovali, aperturâ trifoliatâ; laminâ glabrâ; margine tenui spinis elongatis, gracilibus, 4 armato. Aviculario magno, sessili, in parte anteriori cellulæ, medio posito, mandibulo, rostroque peracutis; ovicellulis rotundatis, magnis.

Adnate; cells pyriform, contracted below; area occupying about half the front of the cell of an oval form, with a smooth thin margin armed with four slender, elongated spines; lamina smooth; aperture obscurely trifoliate in form. A large, prominent, (but not pedunculate,) avicularium placed on the middle of the cell in front, below the area, and having a very acute mandible and rostrum, which are placed transversely; ovicell rounded, prominent.

Hab. Shetland, *Barlee;* on stone.

The strong, prominent avicularium is a striking characteristic of this species. Its mandible and rostrum are both pointed, and the organ is placed transversely with respect to the axis of the cell.

Gen. 3. *Lepralia.* Johnst.

1. *L. sinuosa*, n. sp. Pl. XXIV, figs. 2 and 3.

L. cellulis subrhomboideis, subplanis, lineâ elevatâ, sinuosâ sejunctis, porosis; orificio suborbiculari, infrà sinuato, peristomate tenui, elevato.

Cells subrhomboidal, flattened in front, perforate, separated by a wavy, sinuous line; orifice suborbicular, sinuated below; peristome thin, raised.

Hab. Shetland, *Barlee;* on shell. Cornwall, Peterhead, Ipswich. *Peach.*

My friend Mr. C. Peach is of opinion that this species is identical with one found by him in the localities above cited, and described with a figure in the "Report of the Royal Institution of Cornwall for 1851." But I must confess that his figure leads me to doubt the correctness of Mr. Peach's surmise.

2. *L. Malusii*, Audouin.

Var. Spinis marginalibus armata.

In the 'Brit. Mus. Catalogue,' *L. Malusii* is placed among the unarmed species, but subsequent observation has shown that the form furnished with marginal spines, there cited as a variety, may be more properly regarded as the typical aspect of *L. Malusii*, of which a figure is here introduced, taken from a specimen, in which the mode of origin of a patch from a single, central, abnormal cell is well shown.

DESCRIPTION OF PLATES XXIV & XXV.

PLATE XXIV.

Fig.

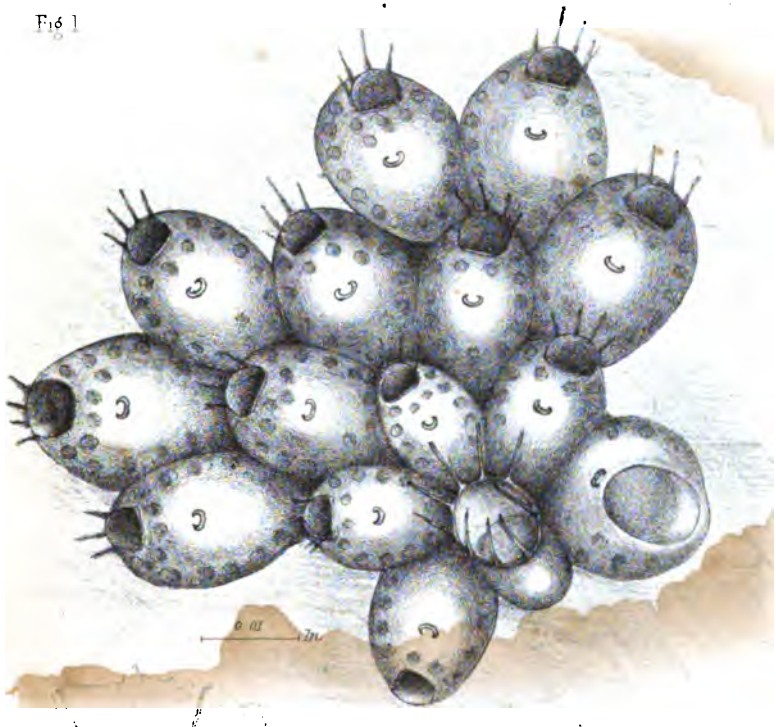
1.—*Lepralia malusii*, p. 125.
2.— „ *sinuosa*, × 25 d., p. 125.
3.— „ „ × 50 d.

PLATE XXV.

1.—*Membranipora rhynchota*, p. 125.
a. Avicularium, open.
b. „ closed.
2.—*M. cornigera*, p. 124.
3.—*M. vulnerata*, p .124.
4.—*Flustra Barlei*, p. 123.
a. Natural size of small fragment.
b. Avicularium, × 50 d.
c. Portion, × 25 d.
5.—*F. truncata*
6.—*F. papyracea* } × 25 d., for comparison.

Plate XXIV

Fig 1



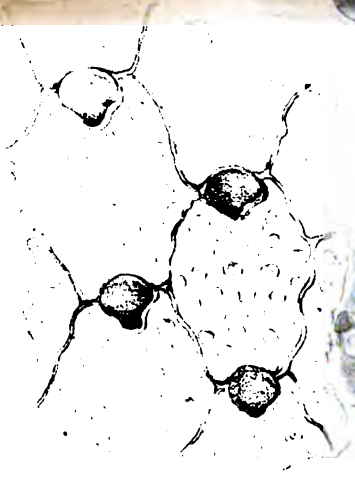


Fig 2

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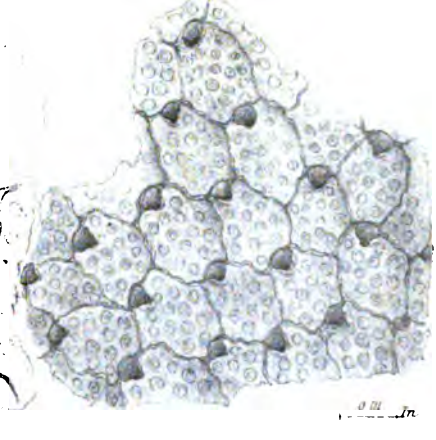

Fig 3

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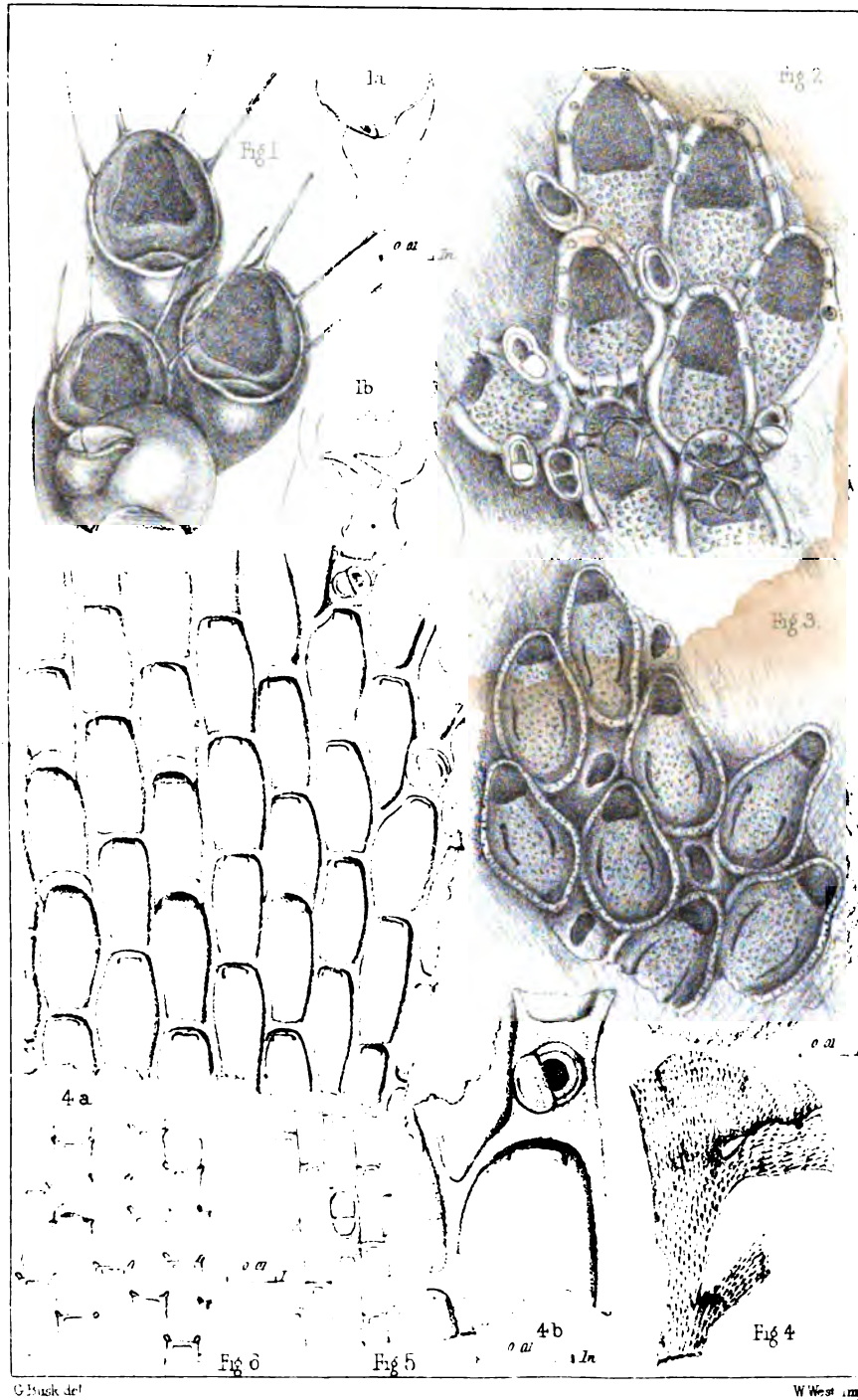
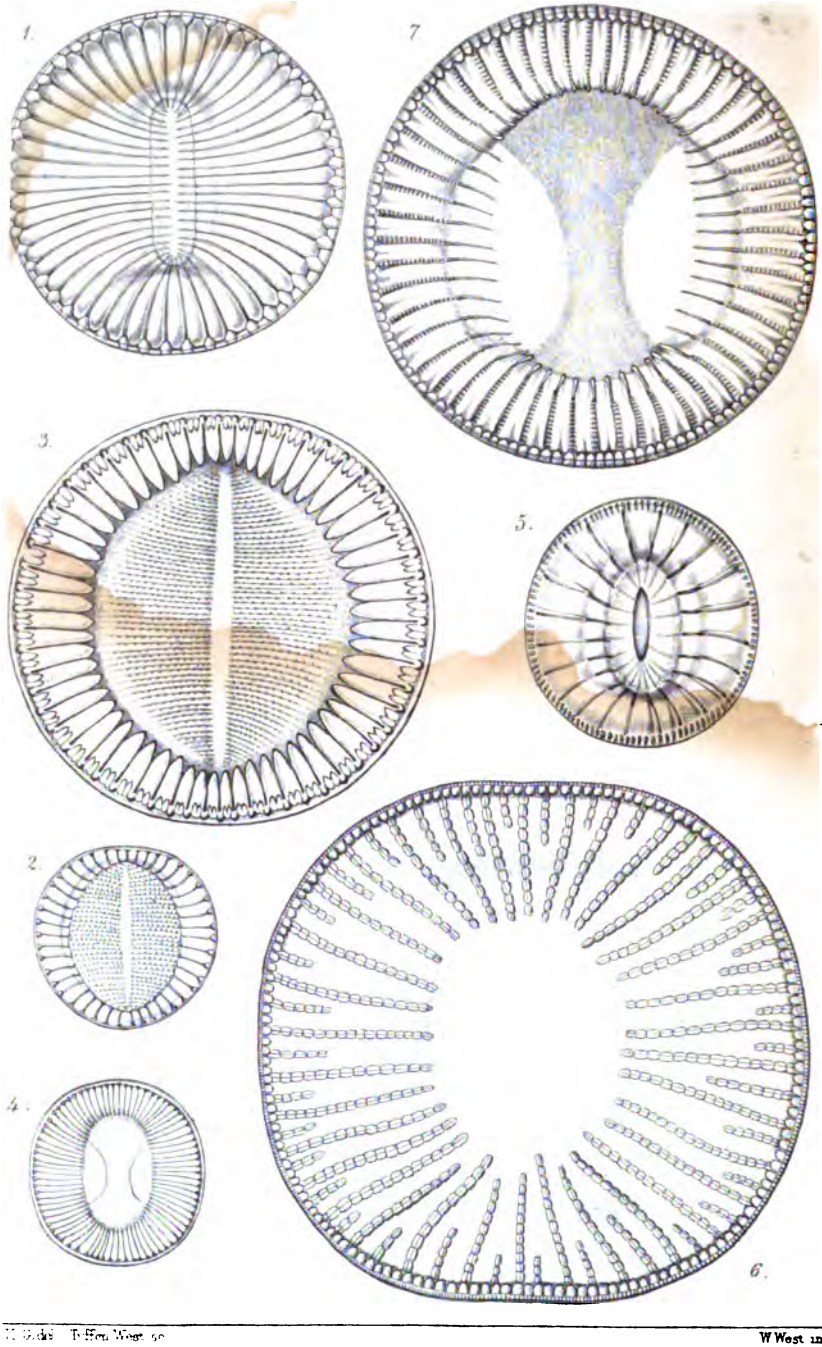
Plate XXV





W West imp

DESCRIPTION OF PLATE I,

Illustrating Dr. Greville's paper on New Species of Campylodiscus.

Fig.

1.—*Campylodiscus Normanianus.*
2.—*C. marginatus*, Johnst.
3.—*C. imperialis.*
4.—*C. notatus.*
5. —*C. ambiguus.*
6.—*C. diplostictus.*
7.—*C. Kittonianus.*

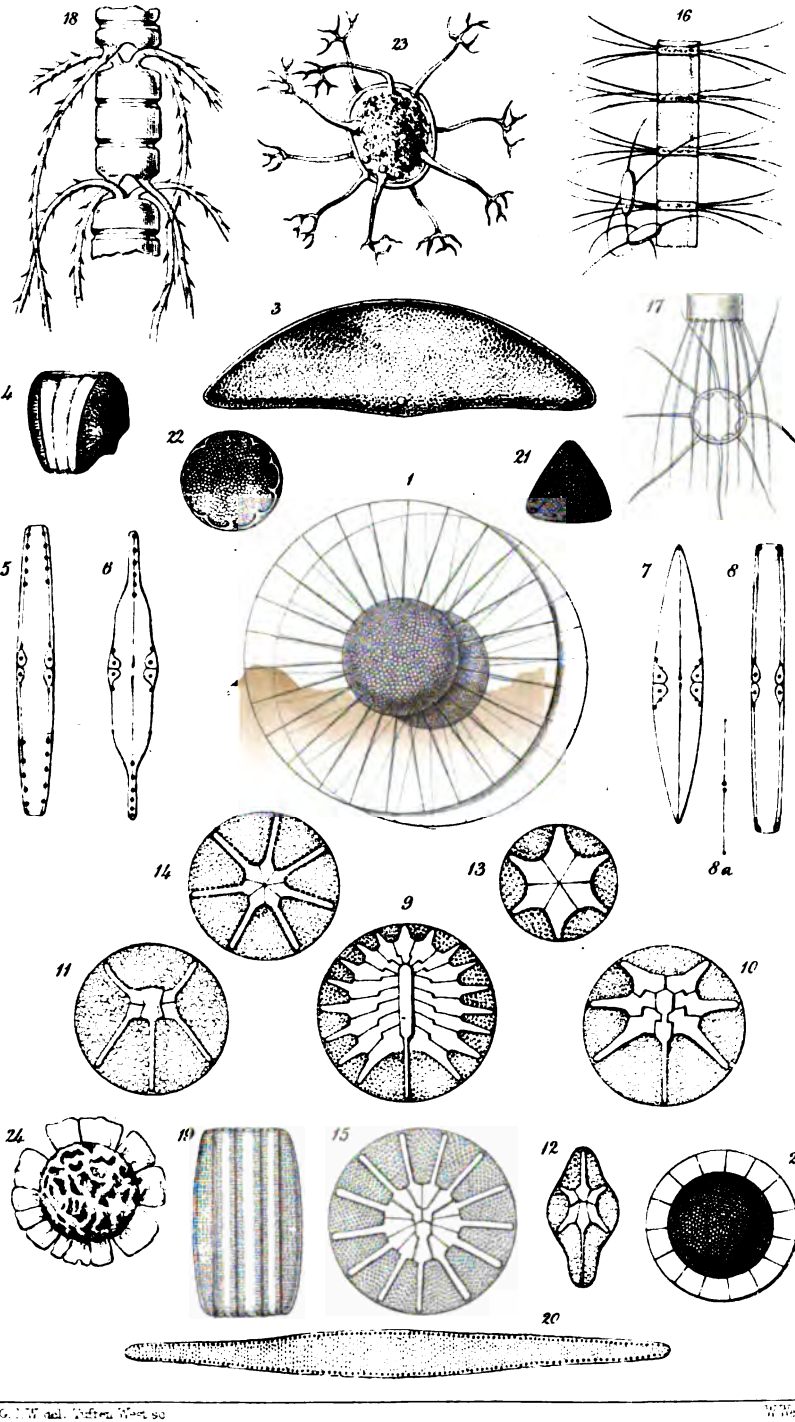
All the figures are × 400 diameters.

DESCRIPTION OF PLATE II,

Illustrating Dr. Wallich's paper on Siliceous Organisms.

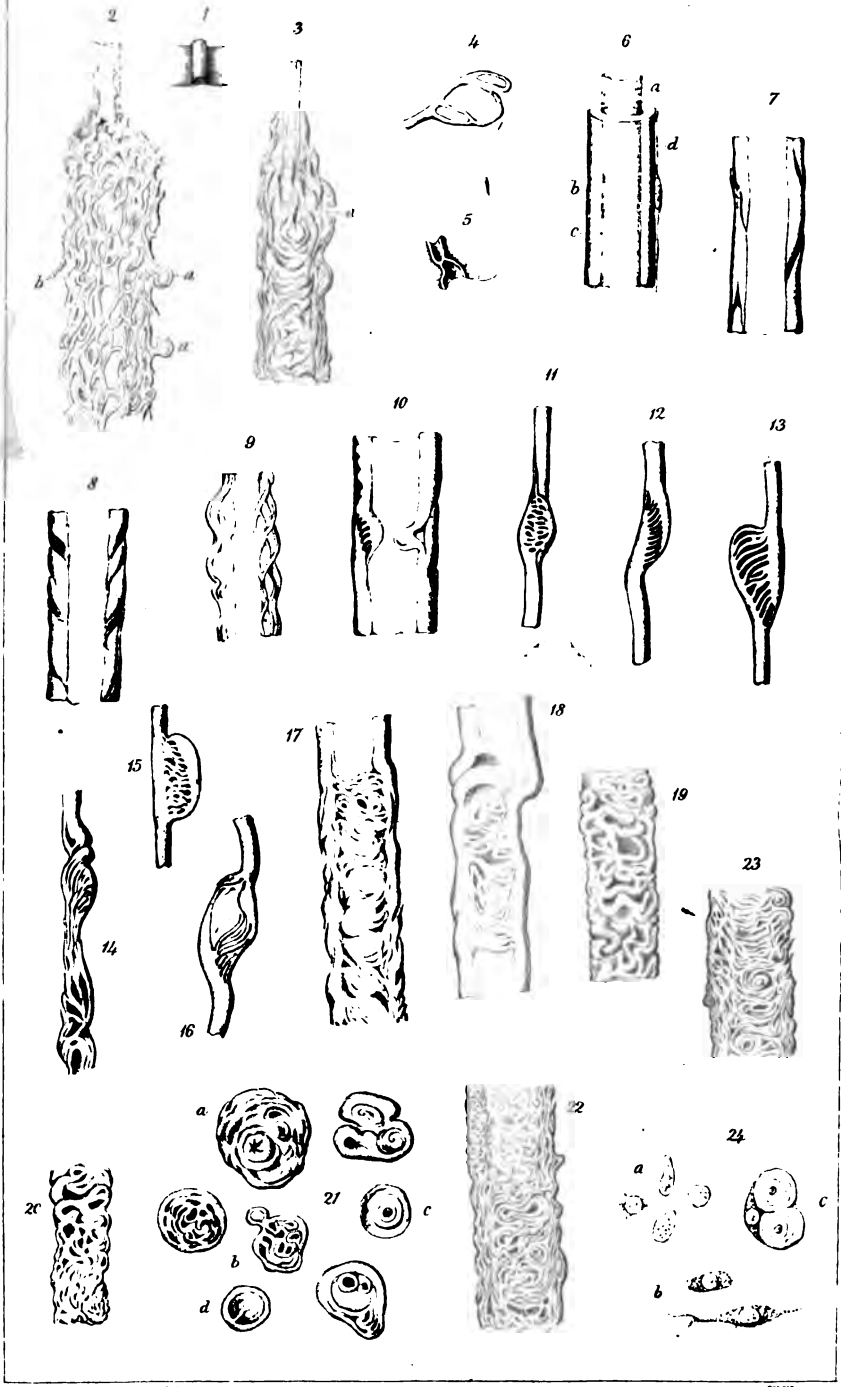
Fig.

1.—*Coscinodiscus Sol*, n. sp.
2.— „ „ var.
3.—*Hemidiscus cuneiformis*, n. sp.
4.— „ „ end view.
5.—*Stigmaphora rostrata*, n. sp., front view.
6.— „ „ side view.
7.— „ *lanceolata*, n. sp., side view.
8.— „ „ front view.
8*a*.—Half of median line of ditto, var., β.
9.—*Asteromphalus imbricatus*, n sp.
10.— „ *elegans*, Grev.
11.— „ *malleiformis*, n. sp.
12.— „ *sarcophagus*, n. sp
13.— „ *Grevillii*, n. sp.
14-15.—*Asterolampra Marylandica*, Bailey.
16.—*Chætoceros bacteriastrum*.
17.— „ „ var.
18.— „ *boreale*, Bailey.
19.—*Synedra doliolus*.
20.—*Nitzschia lanceolata*, Sm., var.
21.—*Triceratium punctatum*, n. sp.
22.—*Coscinodiscus radiatus*, Ehr., var
23.—*Xanthidium* „ ?
24.— „ *vestitum*, White.



G. N. Wood. Tuffen West sc

W. West ir



J. L. Clarke del. Tuffen West sc. W. West imp.

DESCRIPTION OF PLATE IV,

Illustrating Mr. Clarke's paper on Nerve-structure.

Fig.

1.—Represents an elevation or ridge of the white substance on the surface of a primitive nerve-fibre.

2.—A double-contoured primitive-fibre, hardened in chromic acid, and magnified 670 diameters.

3.—A similar fibre treated in the same way, but with its outer corrugated surface more or less broken.

4 & 5.—Two detached portions of a fibre, hardened in chromic acid, showing how the angular bendings give rise to the appearance of fibres or tubules.

6.—An uninjured double-contoured primitive-fibre, examined immediately after death; *a*, axis-cylinder; *b*, outer contour; *c*, inner contour; *d*, membranous sheath bearing an elongated nucleus.

7 to 10.—Represent fresh primitive-fibres, more or less injured by manipulation.

11 to 16.—Represent the white substance of Schwann, between the double contour, after injury by manipulation. At fig. 14 it appears twisted in some places into a kind of knot; while in other places it is simply affected by indentations of various lengths and breadths, which are represented by the dark spaces, the light spaces having the appearance of fibres.

17 to 20.—Represent perfectly fresh primitive-fibres, stretched and otherwise injured in manipulation, by which the white substance has been thrown into variously-shaped convolutions, ridges, or apparent fibres

21.—Represents free globular contents escaped from the nerve-fibres.

22 and 23.—Two fresh nerve-fibres thrown into ridges of various shapes and sizes, under the influence of strong acetic acid. In fig. 23, on the surface of the fibre, are two or three spiral ridges similar to the spirals seen at the cut end of fibres hardened in chromic acid.

24.—*a*, free nuclei from the connective tissue and sheaths of the nerve-fibres in the white columns of the spinal cord; *b*, nucleated cells from the same parts in the calf; *c*, cut ends of two primitive nerve-fibres, hardened in chromic acid, and presenting the appearance of spiral fibres. The angular interspace between them is occupied by a nucleated cell.

DESCRIPTION OF PLATES V, VI,

Illustrating Mr. Brightwell's paper on New or Imperfectly-known Diatomaceæ.

PLATE V.

Fig.

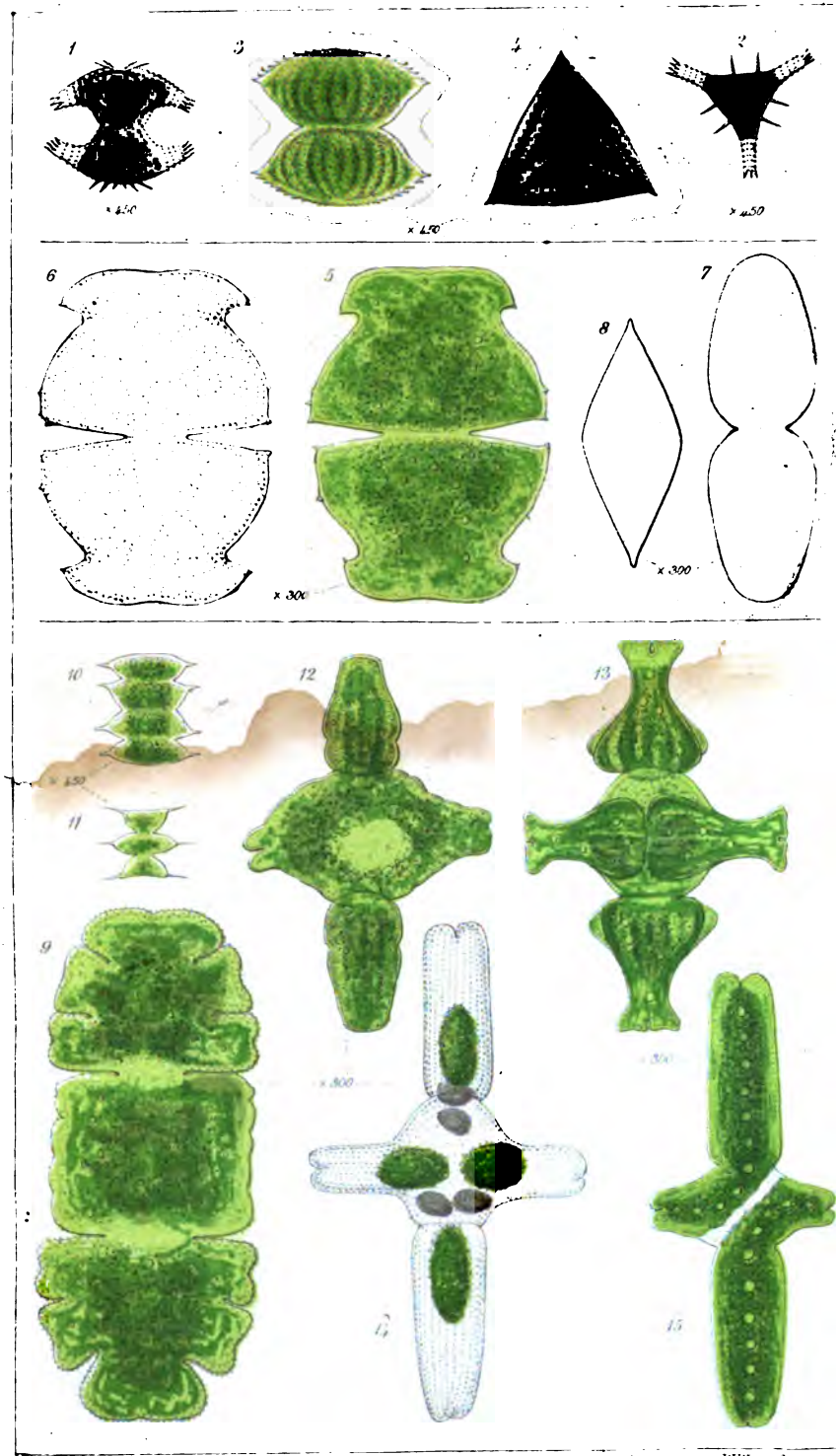
1.—*Actinocyclus areolatus; a*, side view; *b*, front view in outline.
2.—*Actinocyclus*, side view; *a*, front view; *b*, the same of two pustules undergoing self-division, both in outline; these two figures from drawings by Mr. F. Kitton.
3.—*Asterolampra Marylandica*, Ehr., specimen with six segments.
4.—*Craspedodiscus pyxidicula*, Ehr.
5.—*Aulacodiscus sculptus*, front view.
6.—*Craspedodiscus*, n. sp., fragment of a valve.
7.— „ „ side view.
8.—*Stephanogonia polygona*, Ehr.; *a*, side view; *b*, front view.
9.—*Hyalodiscus*.
10.—*Aulacodiscus radiatus*, Bailey; *a*, side view; *b*, front view.

PLATE VI.

11.—*Cyclotella*, n. sp.; *a*, side view; *b*, front view of short filament.
12.—*Craspedodiscus*, n. sp.
13.—*Aulacodiscus*, abnormal specimen.
14.—*Orthosira oceanica*; *a*, side view; *b*, front view of pustule and single valve adherent.
15.—*Actinocyclus*, n. sp.
16.—*Cyclotella*, n. sp.; *a*, side view; *b*, front view.
17.—*Eupodiscus*.
18.—*Actinophænia splendens*, Shadb., showing both coarse and fine markings.

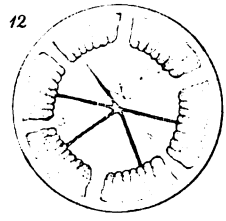
All magnified 400 diameters.

For Description of Plate VII, illustrating Mr. Archer's paper on Desmidiaceæ, see Paper.



W. Anchor del. Tuffen West sculp.

W. West chromo.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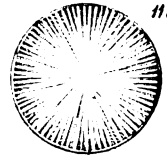
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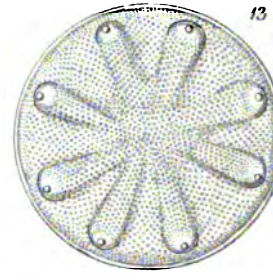
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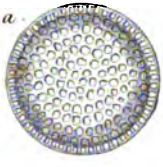
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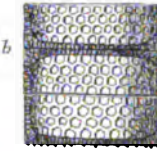
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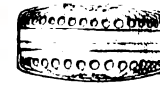
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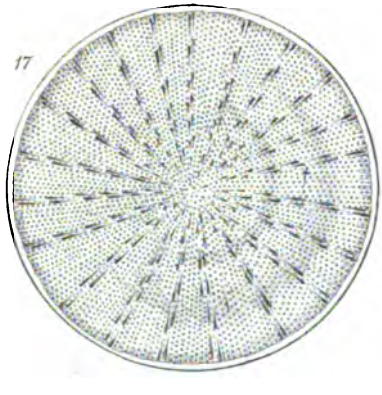
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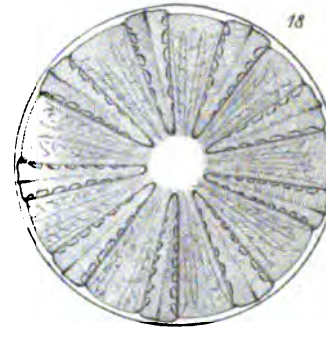
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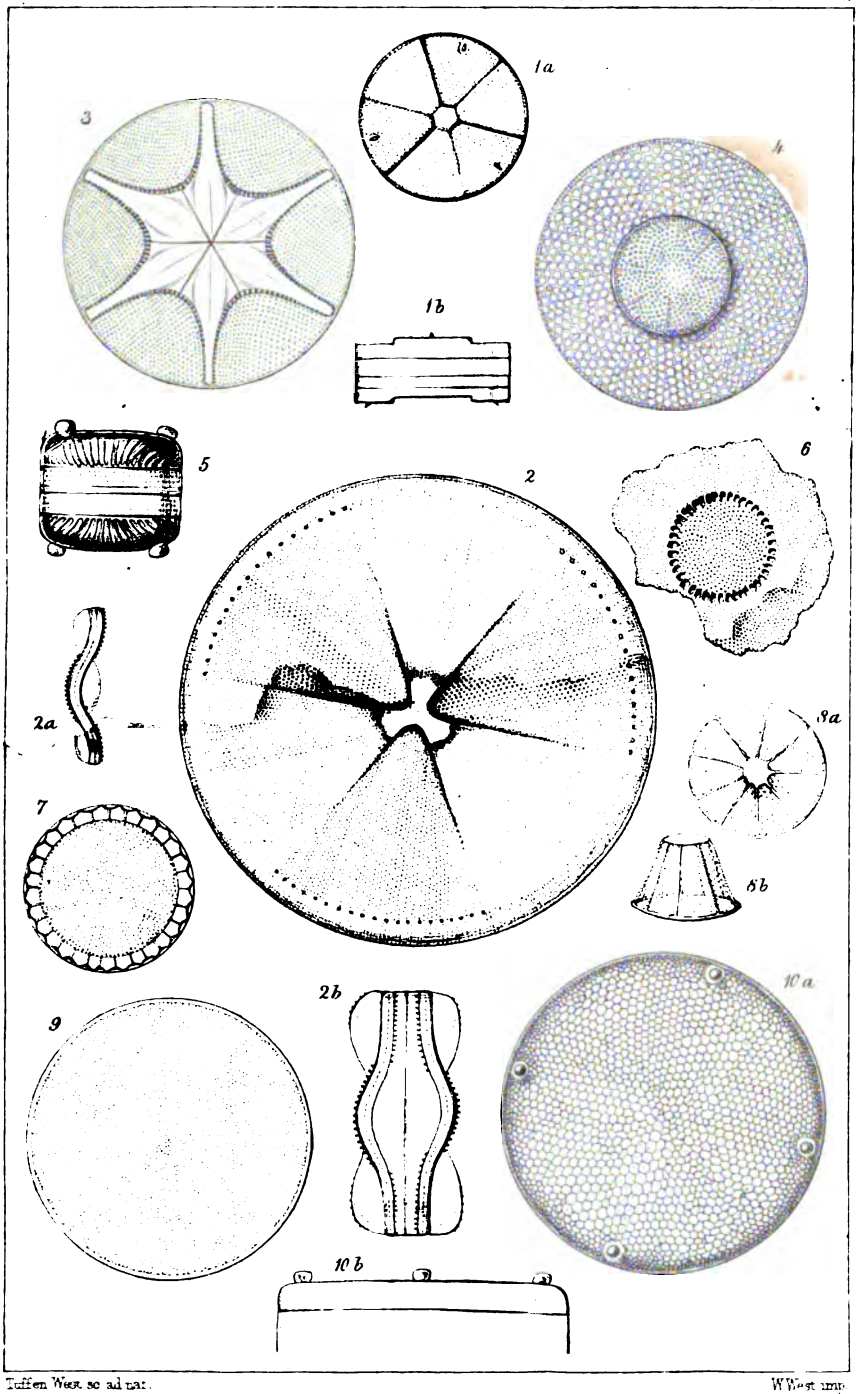
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10b

ORIGINAL COMMUNICATIONS.

On American Diatomaceæ. By Arthur M. Edwards, Esq., New York, U. S.

A paper of mine, on American Diatomaceæ, was read before the London Microscopical Society, March 30th, 1859, and published in their Transactions, in which an omission occurred which I herein wish to rectify. A mistake occurred in re-writing, so that the description of the species found at Charleston harbour, S. C., was left out. A paper on this subject, by the present writer, was read before the New York Lyceum of Natural History, February 21st, 1859, a copy of which is annexed:—

On the Microscopic forms of the Harbour of Charleston, South Carolina.

In the year 1850, Professor Bailey published in the 'Smithsonian Contributions to Knowledge,' a list of the microscopic organisms which he had found in mud collected from the logs of wharves, and from other situations in the harbour of Charleston, S. C., which contained two new species, besides many other curious forms; and in the year 1853, he described four species of Ehrenberg's genus *Auliscus*, three of which are also found at Charleston, though Bailey failed to detect them. Bailey's list is as follows:—

Actiniscus sirius, *Ehr.*
Actinoyclus bioctonarius, *Ehr.*
Actinoptychus senarius, *Ehr.*
Biddulphia pulchella, *Gray.*
Cocconeis scutellum, *Ehr.*
Coscinodiscus eccentricus, *Ehr.*
Dictyocha fibula, *Ehr.*
Eupodiscus Rogersii, *Ehr.*
* „ radiatus, *B.*
Gaillionella sulcata, *Ehr.*
Navicula sigma, *Ehr.*
Pinnularia interrupta, *Ehr.*
„ didyma, *Ehr.*
„ lyra, *Ehr.*
Raphoneis rhombus, *Ehr.*
Stauroptera aspera, *Ehr.*
*Surirella circumstuta, *B.*
Terpsina musica, *Ehr.*
Triceratium favus, *Ehr.*
„ alternans, *B.*

Certain of these have been re-named by later observers,

or have been found to be synonymous with already described species, and should be designated thus:—

Actinocyclus bioctonarius, *Ehr.*	=	Coscinodiscus actinoptychus, *Edw.*
Actinoptychus senarius, *Ehr.*	=	Actinophœnia splendens, *Shad.*
Eupodiscus Rogersii, *Ehr.*	=	Eupodiscus argus, *Ehr.*
Pinnularia didyma, *Ehr.*	=	Navicula didyma, *K.*
„ lyra, *Ehr.*	=	„ lyra, *K.*
Raphoneis rhombus, *Ehr.*	=	Doryphora amphiceros, *K.*
Stauroptera aspera, *Ehr.*	=	Stauroneis pulchella, *W. S.*
Surirella circumstuta, *B.*	=	Tryblionella scutellum, *W. S.*
Gaillionella sulcata, *Ehr.*	=	Orthosira marina, *Ehr.*

Actiniscus sirius, Ehr., and *Dictyocha fibula*, Ehr., are neither of them Diatoms, and are most probably portions of the skeleton of a Holothuria.

Some two years back, I received from a friend residing at Charleston some of the so-called black "pluff" mud, taken from between watermarks, and which I found to be extremely rich in Diatomaceous forms. The following species were observed:—

Actinocyclus undulatus, *Ehr.*
Actinophœnia splendens, *Shad.*
Auliscus cælatus, *B.*
„ pruinosus, *B.*
„ punctatus, *B.*
Biddulphia rhombus, *W. S.*
„ aurita, *Bréb.*
Campylodiscus cribrosus, *W. S.*
Cocconeis scutellum, *Ehr.*
Coscinodiscus actinoptychus. *Edw.*
„ eccentricus, *Ehr.*
„ lineatus, *Ehr.*
„ oculus-iridis, *Ehr.*
„ radiatus, *Ehr.*
„ subtilis, *Ehr.*
Epithemia Hyndmanii, *W. S.*
„ musculus, *K.*
Navicula didyma, *K.*
* „ maculata, *n. sp.*
* „ permagna, *n. sp.*
Nitzschia scalaris, *W. S.*
Pleurosigma angulata, *W. S.*
Triceratium alternans, *B.*
favus, *Ehr.*
punctatum, *T. B.*
Tryblionella scutellum, *W. S.*
„ punctata, *W. S.*

The *Navicula sigma*, Ehr., of Bailey's list, is most probably synonymous with the *Pleurosigma angulata*, W. S., of mine. Those species marked with an asterisk (*) are new, and are characterised as follows:—

Navicula maculata, n. sp.=*Stauroneis maculata*, B., 1850.

"Lanceolate or elliptical; ends slightly produced and rounded; surface punctato-striate, with a large smooth central space." *Bailey.* To this description I have to add the following measurements: length ·055 in.; breadth ·00216 in.; striæ coarsely moniliform, 12 in. ·001 in.

Navicula permagna, n. sp.=*Pinnularia permagna*, B., 1850.

"Large, lanceolate on the ventral faces, with punctato-striate marginal bands, and a broad, smooth central stripe;

ends slightly rounded." *Bailey*. I have as yet only found this species in small quantities, and have been unable to make its measurements. There can be no doubt that these two species should be placed in the genus *Navicula*, as the seeming stauros in the first, the presence of which would seem to rank it in that of *Stauroneis*, is only a blank space, such as is seen in many species of *Navicula*, as *N. elegans*, &c. The presence of moniliform striæ in the second species removes it from *Pinnularia*, which is characterised by its markings being costæ, not resolvable into dots. Of *N. maculata*, I have specimens from Duval's Creek, near Enterprise, Florida, for which I am indebted to Dr. Christopher Johnston, of Baltimore, Md.

I here mention a fact that has come within my notice while examining this gathering. Smith's *Eupodiscus radiatus*, as described and figured in the first volume of his 'Synopsis,' is not the same as the form described under that name by Bailey in 1850. Roper has remarked this same fact ('Trans. Mic. Soc.,' London, vol. vii, p. 19), but was in some doubt until I had the pleasure of forwarding him authentic specimens of it from Bailey's cabinet, when he wrote to me that the examination of them confirmed his opinion that Smith was in error in referring the Thames diatom to that species. It is perfectly distinct, and a true Eupodiscus.

Since the above article was written, I have been lead, by the advice of Dr. Arnott, to reconsider the subject of the species, which I, in my paper on American Diatoms, called *Coscinodiscus actinoptychus*. This belongs to Ehrenberg's genus *Actinocyclus*, the species of which are characterised by the number of rays,—a loose character. It should therefore be placed in that genus for the present, the specific name being left blank until more is known of its natural history.

TRANSLATION.

Atmospheric Micrography. Observations *on the* Corpuscles *suspended in the* Atmosphere. By M. Pouchet.

('Comptes rendus,' March 21st, 1859.)

The atmosphere contains, in suspension, numerous corpuscles, consisting of the detritus of the mineral crust of the earth, animal and vegetable particles, and the minutely divided débris of the various articles employed in our wants. These various kinds of corpuscles are more numerous and more voluminous in proportion to the degree in which the atmosphere is agitated by the wind; and they constitute what we term "dust."

This "dust" being simply the deposit of the corpuscles carried in the atmosphere, it is evident that the attentive study of its composition is simply a microscopic analysis of the air.

The granules of mineral origin, partly going to form the dust, present but little variety. They are derived essentially from the detritus of the rocks which are exposed in the country where the dust is observed.

The débris derived from the animal kingdom consists chiefly of the following articles:—various animalcules in a dry state and of extreme minuteness, such as entozoa belonging to the genus *Oxyuris* and *Vibriones* of several species. I have often also noticed the skeletons of siliceous Infusoria, especially of *Naviculæ*, *Bacillariæ*, and other diatoms; fragments of the antennæ of Coleoptera; scales of diurnal and nocturnal Lepidoptera; fibres of wool of various colours derived from our clothes, often of a beautiful blue, bright red, or green; hairs of the rabbit, bat, &c.; the barblets of feathers; fragments of the tarsi of insects; epithelial cells; fragments of the skin of various insects; particles of cobweb. Twice only, in more than a thousand observations, have I observed one of those large ova of Infusoria having a diameter of 0·0150 mm., denominated by naturalists "cysts."

The corpuscles contained in "dust" belonging to the vegetable kingdom, observed by me, are the following:—frag-

ments of the tissue of various plants; a few ligneous fibres; more frequently fragments of cells and vessels; often hairs of the nettle and other plants; numerous filaments of cotton, usually white, but sometimes of various colours, also derived from articles of dress; some fragments of anthers and pollen-grains of malvaceous plants, of *Epilobium* and *Pinus*; spores of cryptogamous plants, but in very small number. Lastly, I have constantly noticed, and almost invariably where my observations have been extensive, a very notable quantity of wheat-starch mixed with the dust, whether recent or old; and, in rare instances, may be found the starch of oats, barley, and the potato.

It is evident, therefore, that the atmosphere holds in suspension a certain quantity of *wheat-starch* among its dust-corpuscles. This substance is met with in all places where it enters into articles of food, and it may readily be distinguished by its physical and chemical characters. The grains of which it consists are sometimes ovoid, sometimes spherical; in diameter they usually vary from 0·0140 to 0·0280mm. Besides these numerous extremely minute incipient granules, may be seen others less than 0·0028mm. in diameter. The larger grains are very rare; those of a medium size far more common, and the very minute ones extremely abundant. In the large granules the concentric layers and *hilum* may sometimes be readily distinguished. It is rather curious to remark that this starch, notwithstanding, in some instances, its secular existence, still affords all the physical and chemical properties of the recent substance. The only difference being that the very ancient presents a light-yellow tint. When boiled in water it swells and dissolves. Very weak hydrochloric acid has no effect upon it; it is coloured blue by iodine with greater or less intensity; and sometimes its colour disappears under the influence of light. One circumstance which has struck me, is, that among starch found in dust several centuries old, I have, from time to time, met with grains which *had spontaneously assumed a beautiful clear violet colour*. Was this due to the influence of time, or to the vicinity of the sea, or, lastly, according to M. Chatin, to the traces of the vapour of iodine contained in the atmosphere? Finally, that no doubt may be entertained with respect to the identity of this aërial fecula with ordinary starch, I would add, that its effect upon polarized light is the same, except that, when procured from a very ancient deposit, its polarizing property is less energetic.

It is evident that it is this fecula thus perfectly characterised by its physical and chemical properties, that M. De

Quatrefages has taken for the ova of microzoa. It is the most minute grains of this substance to which he refers when he states, that he "could easily recognise in the dust" several of those minute corpuscles of a spherical or ovoid form, well known to all micrographers, and which involuntarily suggest the idea of an extremely minute ovum.* This image is correct, but the illusion is at once dissipated by the slightest chemical test, which proves that the granules in question can be nothing else than either extremely fine amylaceous grains or siliceous particles, which I have frequently observed, and which are of such extreme tenuity, as under the microscope to present the appearance of transparent spherical granules.

Astonished at the comparative abundance of the amylaceous particles which I found among the atmospheric corpuscles, and in order to obtain a rigorous demonstration of the fact, I determined to examine dust of all ages and from all localities. I have investigated the monuments of our great cities, others on the sea-shore and in the desert; and, in the midst of the immense variety of corpuscles universally floating in the air, have almost everywhere met with starch in greater or less abundance. Gifted with an extraordinary self-conservative power, time seems scarcely to affect it.

However remote may be the antiquity of the atmospheric corpuscles, starch still recognisable is found among them. I have discovered its presence in the most inaccessible recesses of our old Gothic churches mixed with the dust, blackened by an existence of from six to eight centuries. I have even found it in the palaces and subterranean chambers of the Thebaid, where it would date probably from the epoch of the Pharaohs.

It may be affirmed, as a general proposition, that in all countries where wheat constitutes the basis of food, its starchy element penetrates everywhere with the dust, and is found mixed with it in more or less considerable quantity. It is more abundant in situations near the centre of towns and at a low level, whilst, in proportion as we go to greater distances from the great centres of population, and explore the more isolated monuments, does the starch become less and less abundant, and its grains more and more minute. I have been unable to detect any either in the Temple of Jupiter Serapis, situated on the shores of the Gulf of Baiæ, or in that of Venus Athor, placed on the confines of Nubia. Nevertheless, I have collected some in subterranean temples of Upper Egypt.

* 'Comptes rend.,' Paris, 1859, t. xlviii, p. 31.

It is remarked also, that in proportion to the elevation reached on mountains or on buildings, the amount of fecula mixed with the atmospheric detritus is diminished. In the Abbey of Fécamp, which is below the level of the ground, and situated in the middle of the town, starch abounds in the dust of its chapels. In the Cathedral of Rouen a considerable quantity is met with in the lower part of the tower of Georges d'Amboise, the proportion gradually diminishing as we ascend. Whilst still abundant in the ancient dust found in the roof of the choir, it becomes more and more rare when we mount into the spire. Very little is found at the base of the cast-iron pyramid, and not a single grain at its summit.

In an isolated chapel situated on the sea-shore, and built on a beach about 110 metres in elevation, the dust lodged on a statue was composed, in great part, of calcareous particles, derived from the sides of the mountain, and conveyed by the wind to the floor of the building, which is open day and night to pilgrims. In the same situation were also found a great number of scales of lepidopterous insects, which had, doubtless, often sought shelter there; but very rarely was a grain of starch perceived in the field of the microscope; whilst in the detritus of towns, on every trial, several grains of a medium size, and a considerable number of more minute dimensions, would have been noticed.

A battery also placed on the shore, and in an isolated situation, and which had not been opened for sixty years, afforded a black dust, which was as poor in starch as that of the chapel above mentioned. But the dust itself was of a wholly different nature, being composed almost entirely of very angular, transparent, colourless particles of silex. The starch was so scarce in this dust, that often not more than a single grain could be discovered in a dozen observations.

This dissemination is a phenomenon so general and so widely diffused in places where wheat is used for food, that there is no nook or corner into which starch does not insinuate itself with the air. It is found in everything, and in all situations into which the latter penetrates. The most obscure corners of our Gothic buildings have afforded this substance in the ancient dust which had never been disturbed in the memory of man. I have even found it in the *interior* of the cavity of the tympanum in the skull of a mummified dog which I procured from a subterranean temple in Upper Egypt. M. Ch. Robin, whose observations accord with mine, has discovered starch on the surface of the human skin, whence it may be procured by scraping

with a sharp instrument either in the dead body or of a living person.

All these observations, if it were needed, might be supported by biological proofs. Until the contrary can be shown experimentally, it may be said that the air is so rarely the vehicle of ova, and the dust so rarely their receptacle, that when the latter is subjected to an elevated temperature, it is no less fecund in animalcules than that which has not been heated; which would not be the case, were the hypothesis of aerian dissemination of ova founded in truth.

I have often repeated the following experiment. I have taken 3 grammes of an ancient dust, and placed it in a thin tube, heated to 215° C., in an oil-bath, for an hour and a quarter. The dust has afterwards been put into 30 grammes of artificial water, and the whole covered with a bell-glass. At the end of five days, and at a mean temperature of 20° C., the water was crowded with animalcules of large size—*Colpoda* and *Paramœcium*. The same result takes place with dust which has not been heated. What has been taken, therefore, for ova deposited from the atmosphere, was not really such; for, in that case, the dust which had been heated would have been infertile, the germs contained in it having been killed by a temperature of 215° C.

Another very simple experiment also proves that it is impossible to discover any living germ in the atmosphere. By means of an inhaling flask I caused 100 litres of air to pass through a safety tube whose bulb contained two cubic centimetres of distilled water. At the end of eight days I was unable to discover a single animalcule or ovum in this small quantity of water, in which the latter, themselves, could not escape observation, now that they have been completely described and measured, and are well known in several species. On the contrary, if I place in a cubic decimetre of distilled water 5 grammes of a fermentable substance, sheltered by a bell-glass having a capacity of one litre, at the end of eight days, and at a temperature of 18° C., the whole surface of the water is occupied by incalculable myriads of animalcules.

The memoir concludes with the detail of particular observations on dust collected in the following localities:

Tower of Georges d'Amboise, at Rouen. Interior of the Abbey at Fécamp. Ruins of Thebes. Tomb of Ramses II. Sepulchral chamber of the Great Pyramid. Temple of Venus Athor, at Philoe. Temple of Serapis, at Puzzuoli. Skull of a mummified dog, from the subterranean vaults of Beni-Hassan. The cabinet of a Jewish antiquarian at Cairo.

NOTES AND CORRESPONDENCE.

Angular Aperture.—My object in the paper on the subject of angular aperture, which you were good enough to insert (p. 256, last volume), was simply to facilitate the application of Mr. Lister's method of measurement, by showing how that method might be made available independently of the special apparatus usually considered requisite for this purpose. Mr. Hendry, therefore (p. 61, present volume), is mistaken if he supposes, as he seems to do, that I claim for the method, as described by me, *superiority in point of accuracy* to the method as usually practised. I do not do that, but I claim for it *equality* in this respect. An angle is determined quite as accurately by measurement of the sides of the triangle to which it belongs, as by measurement of its subtending arc. The use of two candles saves the trouble of moving the one candle, if one only is used, from one side of the field of view to the other; and the indication of these being properly placed will easily be found to be in exact accordance with the corresponding indication in Mr. Lister's method, as usually described.

But I am surprised at Mr. Hendry's statement, that "my rule gave no provision for angles exceeding 90°." I know of no ground for this statement. Take his fourth example:

Lights apart, 44 inches; distance of lens, 10 inches.

Hence $44 \div (10 \times 2) = 2{\cdot}2$. On reference to Hutton's Tables, I find this to be the tangent of 65° 33′. The aperture therefore is 131° 6′.

Mr. Hendry, perhaps, has only a table of *logarithmic* tangents. Very well. The logarithm of 2·2 is 0·3424, to which adding 10, to accommodate it to the tabular radius, it becomes 10·3424; and this is the logarithmic tangent of 65° 33′, as before.—M. Gray, 7, St. Paul's Villas, Camden Town, December 5th, 1859.

A New Cement for mounting Objects for the Microscope, either in dry cells or in fluid.—I have found that great rapidity is obtained in mounting objects in a cement made with as-

phaltum dissolved in *Benzine* or *Benzole* instead of turpentine, because it dries so quickly that a great many more objects can be mounted and finished in a day with it than with any other cement. I finish it off with a coat of asphalt in turpentine, to give it a smooth appearance.

It should be kept, like all cements for the mounting of microscopic objects, in a capped bottle, so that the brush is always soft and ready for use.

Benzole is also the most convenient solvent for removing superfluous balsam from the outside of the glass covers under which objects are mounted in that medium.—J. W. Lawrance, Peterborough.*

Registration of Objects.—I beg to subjoin notice of a simple mode of registering objects on slides, which was devised by me in India, and has answered all ordinary purposes so efficiently as to induce me to hope it may prove useful to microscopists.

It possesses three great advantages,—in requiring no separate apparatus, no special adjustment of slides or stage, and costing nothing. It is adapted for use with all the higher powers of the microscope. Although more readily available where the body of the instrument admits of lateral displacement, it may nevertheless be used where no such arrangement exists, by simply elevating the body to a sufficient height to allow of the bearings of the spot of light given off from the illuminator being accurately taken by the eye and hand.

Suppose an object to be in the centre of the field of vision. The body of the microscope is either turned aside or raised, as the case may be. The slide being securely clamped in position, two minute marks are made, with a writing diamond, perpendicularly above, and in a line horizontal with, the spot of light thrown upon the object by the condenser. The smaller the spot of light, of course, the more easy will it be to denote the situation of an object accurately. The slide is now removed, and the scratches are converted into short vertical and horizontal lines, varying in length according to convenience. These two lines are now joined together by a third line; and, lastly, a number is attached, at either angle thus formed, for entry in the note-book or catalogue of the observer.

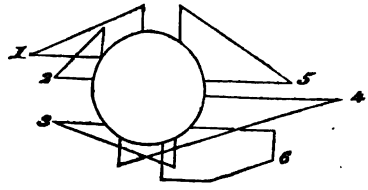
To find the object again, all that has to be done is to place the slide on the stage, and the body of the microscope being

* The addition of a little gold size to the solution of asphaltum in benzine will be found useful in rendering it less brittle.—[Eds.]

either turned aside or elevated as before, to move the slide to and fro, either by hand or stage movements, until the spot of light from the condenser indicates the spot at which the vertical and horizontal lines beyond the margin of the cover would intersect each other, if produced.

Of course, upon the accuracy with which the bearings have been taken will depend the facility of finding an object. But with ordinary care and a tolerably true eye, there is no difficulty.

The following diagram will show the mode of registry, and how it may be applied to any number of objects on the same slide—



The dots, it is almost unnecessary to remark, are appended merely with a view to indicate the points at which the objects to be registered occur.—G. L. WALLICH.

Improvement of the Camera Lucida.—One of M. Nachet's ingenious applications of the prism to the microscope furnishes a hint for the improvement of the camera lucida, which I desire to bring under the notice of yourself and your readers. I refer to the arrangement described and figured on p. 706 of the second edition of Dr. Carpenter's work on the microscope. A prism of peculiar form is there seen, applied as a camera lucida to a vertical microscope.

To the arrangement in question, *as a whole*, I do not attach much importance; for, first, our English microscopes are generally of too tall a *build* to admit of being at all commodiously used in a vertical position for any length of time; and, secondly, if they could be commodiously so used, the stage would be in the way of the hand; while, moreover, the paper not being in the place where *it seems to be*, but away in front of the instrument, I venture to think that this would seriously interfere with the free use of the pencil in tracing the image.

It is to a small adjunct of M. Nachet's prism that I refer, as holding out a prospect of advantage; I mean the *piece*, marked E, in Dr. Carpenter's figure. It is well known that many—perhaps most—microscopists find considerable

difficulty in using the camera lucida as at present constructed, owing to the constrained position in which the eye must be held, half the pupil over and half beyond the edge of the prism. A partial remedy for this difficulty would be found in discarding the present form of prism, with its two reflecting surfaces, and using a prism having only one such surface, and drilling a small hole through it vertically. Through this hole the paper would be seen, while the image would be visible by the rays reflected from the inclined surface of the prism. The objection to this is that the hole would act, as regards the rays entering the prism, as an opaque rod, and so render useless the portion of the reflecting surface immediately behind it. A complete remedy for the difficulty is suggested by inspection of Dr. Carpenter's figure. Instead of making a hole in the prism, let there be attached to the centre of its inclined surface, by Canada balsam, an oblique segment of a small glass cylinder,* so that its base should be parallel to the upper surface of the prism. The effect now, on looking into the prism, will be precisely that of a a hole through it, without the drawback attendant upon an actual hole. The paper will be clearly seen through the prism and the cylinder, and the image by reflection from the inclined surface of the prism, the whole of which surface will now be available, with the exception of the spot where the cylindrical segment is attached, which, however, will be so small as not to be productive of any injurious effect. In fine, so far as I at present see, I feel warranted in expressing a belief that by the adoption of the arrangement now suggested, the difficulty hitherto attendant on the use of the camera lucida would be entirely prevented.

It has often been matter of wonder with me why our opticians continue to supply, for microscopical purposes, the prism with *two* reflecting surfaces. These are requisite in other applications of the camera, for the erection of the image. But in its application to the microscope we do not want this.† What we want, if we had a preference in the matter, is that the inversion caused by the first reflection be

* Dr. Carpenter calls Nachet's "piece E" a prism. I think he must be wrong. The *quasi* hole will be of the form of a direct section of the *piece* employed. A square prism would give a *square* hole, and a cylinder a *circular* one.

† A polished steel disc (Amici's *disc*) has sometimes been employed instead of the more usual Wollaston's camera. But the latter will always be preferred by those who draw from the microscope, simply for the reason that the image thrown on the paper by it corresponds in position with that viewed through the microscope.—[EDS.]

left alone. I should think that a prism with only one reflecting surface would be much more easily worked than one with two. A prism of the latter form, however, is spoiled by the slightest clipping of the edge; while, in the arrangement I have proposed, the edge does not come into use—and it might perhaps be found more advantageous in the working to have the edges truncated.—P. GRAY, 7, St. Paul's Villas, Camden Town, N.W.

On the RARER *and* UNDESCRIBED SPECIES *of* DIATOMACEÆ. By T. BRIGHTWELL, F.L.S. Part II.

ERRATA ET CORRIGENDA.

I regret to find the following errors have crept into my last paper which need correction.

TEXT.

Page 94, line 4, *insert* reference to plate "(Pl. VI, fig. 15)."
„ 94, „ 8, *for* "fig. 15," *read* "18."
„ 94, „ 4 from bottom, *instead of* "*Aulacodiscus*," *read* "*Auliscus sculptus* = *A. cælatus*, Bailey."
„ 95, line 1, *for* "*Aulacodiscus*," *read* "*Eupodiscus*."
„ 95, „ 6, "*Aulacodiscus lævis*." I find this form has been named and distributed by Dr. Arnott as "*A Kittoni;*" the specific name of "*lævis*" must, therefore, be cancelled, and "*Kittoni*" substituted.
„ 95, line 19, the specific name should be "*coscinodiscus*," *instead of* "*pyxidicula*."
„ 96, line 6, *for* "·019 to 0·3," *read* "·0019 to ·0030."

One general error runs through all the measurements; they require an additional ·0 in front.

DESCRIPTION OF PLATES.

Plate V.

Fig. 2, *insert* specific name "*trilingulatus*."
„ 4, *for* "*pyxidicula*," *read* "*coscinodiscus*."
„ 5, *for* "*Aulacodiscus*," *read* "*Auliscus*."
„ 6, *insert* specific name "*coronatus*."
„ 7, „ „ „ "*marginatus*."
„ 9, „ „ „ "*cervinus*."
„ 10, *for* "*Aulacodiscus*," *read* "*Eupodiscus*."

Plate VI.

Fig. 11, *insert* specific name "*radiata*."
„ 12, „ „ „ "*semiplanus*."
„ 13, „ „ „ "*Kittoni*."
„ 15, „ „ „ "*spinosa*."
„ 16, „ „ „ "*stylorum*."
„ 17, *for* "*Eupodiscus*," *read* "*Actinoptychus interpunctatus*."

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *January 11th*, 1860.

Dr. Lankester, President, in the chair.

The minutes of the preceding meeting were read and confirmed.

J. A. Tulk, Esq., 5, East Preston-street, Edinburgh; J. C. Forsyth, Esq., Stoke-upon-Trent; and George Kelly, Esq., 9, Sutherland-gardens, Maida-vale, were balloted for, and duly elected members of the Society.

The following papers were read:

1. 'On the Localities of Diatomaceæ,' by Mr. Norman. ('Trans.,' p. 59.)

2. 'On the Reproduction of Confervoid Algæ,' by Mr. Druce. ('Trans.', p. 71.)

The following letter, addressed to the President, was read:—

"My dear Sir,—I send you three slides of the same object.

"No. 1, mounted in balsam, without any preparation except washing away the salt water.

"No. 2, the same burned on the cover, and mounted dry.

"No. 3, the same neither boiled nor burned, and mounted in fluid. It is probable that, in this last, all the objects may, during the transit, be deposited on one side of the cell, but a little shaking will perhaps cause them to become again scattered, as they were when mounted.

"The first time that it came under my notice, it was sent me, 11th September, 1858, by the Rev. R. Taylor, of Bedlington, from the coast of Northumberland. I afterwards received it from Mr. Mansfield Browne, of Liverpool, collected on that coast. Thereafter it was sent me by Mr. Roper, from the Norfolk coast; by Mr. G. Norman, of Hull, from near the mouth of the Humber; and the other day, I received an immense quantity of it from Mrs. Macdonald, of St. Andrews, Fifeshire.

"In all these cases it is found on very shallow pools among the sands; it floats on the surface and forms extensive patches. If sand adheres, it is easily separated by a slight shaking in the bottle in which it is collected.

"Some have supposed it a diatom allied to *Biddulphia Bayleyi*. From its filamentous nature, and having long spines or cilia, it might, if diatomaceous, be approached to *Biddulphia;* but it takes in turpentine and balsam when dried without being boiled or burned. Now this can only take place on the supposition either that there are no partitions (or valves at the joint—in other words, that the tube is continuous), or that the wall is porous; either of which is contrary to its being a diatom at all.

"Some of my correspondents suppose it to be the exuviæ of an annelid; but no one can point out either genus or species.

"An object of such abundance on our coasts (at St. Andrews I am informed that a pint of it could have been collected in a few minutes) must surely be well known to the London microscopists; and therefore I send you the slides in the hope that, through its members, you will be able to throw some light on the point.

"I shall send a supply of the object itself to Mr. J. T. Norman, the well-known preparer of microscopic objects; so that any one requiring slides may have them from him. They are best seen on the cover, dry, and not burned; but, unless burned, they are apt to imbibe damp, and the slide becomes useless in a year or two. I therefore, myself, prefer them when mounted dry, after being burned.

"Yours truly,

"G. Walker Arnott."

"Victoria-terrace,
"Dowanhill, near Glasgow."

Josh. Gratton, Esq., and R. Beck, Esq., were appointed auditors of the Treasurer's account.

February 8th, 1860.

ANNIVERSARY MEETING.

Dr. Lankester, President, in the chair.

The minutes of the preceding meeting were read and confirmed.

Reports from the Council and the Library Committee were read, together with the Auditors' Report on the Treasurer's accounts; there remaining in his hands a balance of £25 16*s*. 10*d*.

Resolved that these Reports be received and adopted.

R. Lloyd, Esq., 69, Holborn-hill; and H. W. Elphinstone, Esq., 45, Cadogan-place, were balloted for, and duly elected members of the Society.

The President delivered an address on the progress of the Society, and of microscopical science generally, during the past year.

Resolved, that the address now read be printed and circulated in the usual manner, with the Reports of the Council, the Library Committee, and the Auditors.

March 14*th*, 1860.

GEORGE JACKSON, Esq., in the chair.

John Shepperd, Esq., 11, Sussex-place, Regent's-park; and Thomas Ketteringham, Esq., 51, Coleshill-street, Chelsea, were balloted for and duly elected members of the Society.

The following papers were read:—

'On the Development of the Diatom-valve,' by Dr. Wallich. ('Trans.,' p. 129.)

'On Asterolampra, and some other species of Diatomaceæ,' by Dr. Greville. ('Trans.,' p. 102.)

'On the Amœboid Conditions of *Volvox globator*,' by Dr. Hicks. ('Trans.,' p. 99.)

'On a New Zoophyte,' by Dr. Allman. ('Trans.,' p. 125.)

ZOOPHYTOLOGY.

Shetland Polyzoa. Collected by Mr. Barlee. (*Continued.*)

2. *L. Barleei*, n. sp. Pl. XXVI, figs. 1, 2.

L. cellulis ovoideis, convexis, superficie granulosâ; orificio orbiculari infra sinuato, peristomate simplici elevato; ovicellulis decumbentibus adnatis, ad marginem supra perforatis.

Cells ovoid, convex; surface granular; orifice orbicular with a sinus below, peristome thin, raised; ovicells adnate, decumbent, punctured round the border above.

Hab. Shetland, *Barlee;* on shell.

3. *L. cantharifórmis*, n. sp. Pl. XXVI, figs. 3, 4.

L. cellulis late ovoideis, superficie granulosâ, punctatâ, nitidâ; orificio magno, suborbiculari seu irregulari, peristomate producto, sæpius infundibuliformi, integro.

Cells broadly ovoid, surface granular, punctate, shining; orifice large, suborbicular, oblong, or irregular; peristome much produced, often infundibuliform, entire.

Hab. Shetland, *Barlee;* on shell.

4. *L. umbonata*, n. sp. Pl. XXVII, fig. 1.

L. cellulis oblongis, seriatis, lineâ elevatâ sejunctis; ad latera perforatis, medio umbonatis, et juxta orificium mediò avicularium mandibulo semicirculari horizontali gerentibus; orificio suborbiculari, infra paullulum constricto, peristomate simplici spinis 4; supra armato; ovicellulis umbonatis vittamque parvam utrinque ostendentibus.

Cells oblong, serial, parted by a narrow raised line, punctured on the sides, and sometimes in front, with smaller pores; furnished with a central umbo, and having a prominent avicularium with a semicircular horizontal mandible immediately below the orifice; orifice suborbicular, or sometimes contracted below; peristome simple, with four spines above; ovicell large, rounded, umbonate, with a small vitta or depressed area placed obliquely on each side below.

Hab. Shetland, *Barlee;* on stone.

The only species with which this can well be confounded is *L. verrucosa*, which possesses a similar suboral avicularium, but always wants, I believe, the central umbo on the cell and on the ovicell, as well as the vittæ on each side of the latter, which are not unlike those on the ovicell of *L. figularis*, only smaller. In *L. verrucosa*, also, the ovicell is punctured,

whilst in *L. umbonata* its walls are apparently entire. The umbo on the ovicell, it may be remarked, is merely that belonging to the cell in front of which the ovicell rises.

5. *L. bella*, n. sp. Pl. XXVII, fig. 2.

L. cellulis ovoideis, perforatis; orificio suborbiculari, infra sinuato, denticulum internum bifidum ostendenti; peristomato, elevato, subinde incrassato, inermi; ovicellulis rotundatis perforatis.

Cells ovate, punctured; orifice orbicular, with a spout-like sinus below, within which is a rather large, bifid denticle; peristome raised, often thickened; ovicell subglobose, punctured.

Hab. Shetland, *Barlee;* on shell.

This is the species which I doubtfully termed *L. Landsborovii*, when the account of Mr. Barlee's species was read at the British Association. It is clearly, however, not that species as now understood, however much the figures here given may seem to correspond with that of *L. Landsborovii*, in Plate LXXXVI, of the 'British Museum Catalogue.' That figure was taken from the only specimen of *L. Landsborovii* contained in the Johnstonian Collection, and which was the sole representative of the species I had then seen. Since then, however, having received numerous and more perfect specimens, I have been able to determine the characters of the species more precisely; and Fig. 1, Plate CII, of the 'British Museum Catalogue,' erroneously referred to *L. reticulata*, may perhaps be taken as representing its typical form.

The differences between *L. bella* and *L. Landsborovii* consist—

1. In the absence in the former of the intercellular raised line, and

2. In the absence of any avicularian organ on the lower border of the orifice.

From *L. reticulata* and *L. pertusa* the differences are too obvious to require more particular notice.

The other species of *Lepralia* which occur in Mr. Barlee's collection are—

6. *L. Pallasiana*, Moll.

7. *L. bispinosa*, Johnston.

8. *L. granifera*, Johnston.

9. *L. ringens*, Busk.

10. *L. discoidea*, Busk. Pl. XXVII, figs. 4, 5.

The figure of this species, which in some respects closely approaches an *Alysidota*, was inadvertently placed on the stone, before I remembered that it had been already figured in ('Zoophytology') Pl. XXII, figs. 7, 8, from specimens

collected in Madeira by Mr. J. Y. Johnson. As I am unable to discover any satisfactory specific distinction between the northern and southern forms, I am induced to consider them identical.*

Other species belonging to the family *Membraniporidæ*, which occur in Mr. Barlee's collection, are—

1. *Membranipora Rosseli*, Savign.
2. „ *Pouilletii*, Savign.
3. „ *spinifera*, Alder.
4. *Alysidota Alderi*, Busk, which appears to be very abundant.

* In the paper read at the meeting of the British Association, this species was termed *Alysidota conferta*.

(*To be continued.*)

DESCRIPTION OF PLATES XXVI & XXVII.

PLATE XXVI.

Fig.

1 and 2.—*Lepralia Barleei*, p. 143.

3 and 4.—*L. cantharifórmis*, p. 143.

PLATE XXVII.

1.—*Lepralia umbonata*, p. 143.

2 and 3.—*L. bella*, p. 144.

4 and 5.—*L. discoidea*, p. 144.

Plate XXVI.

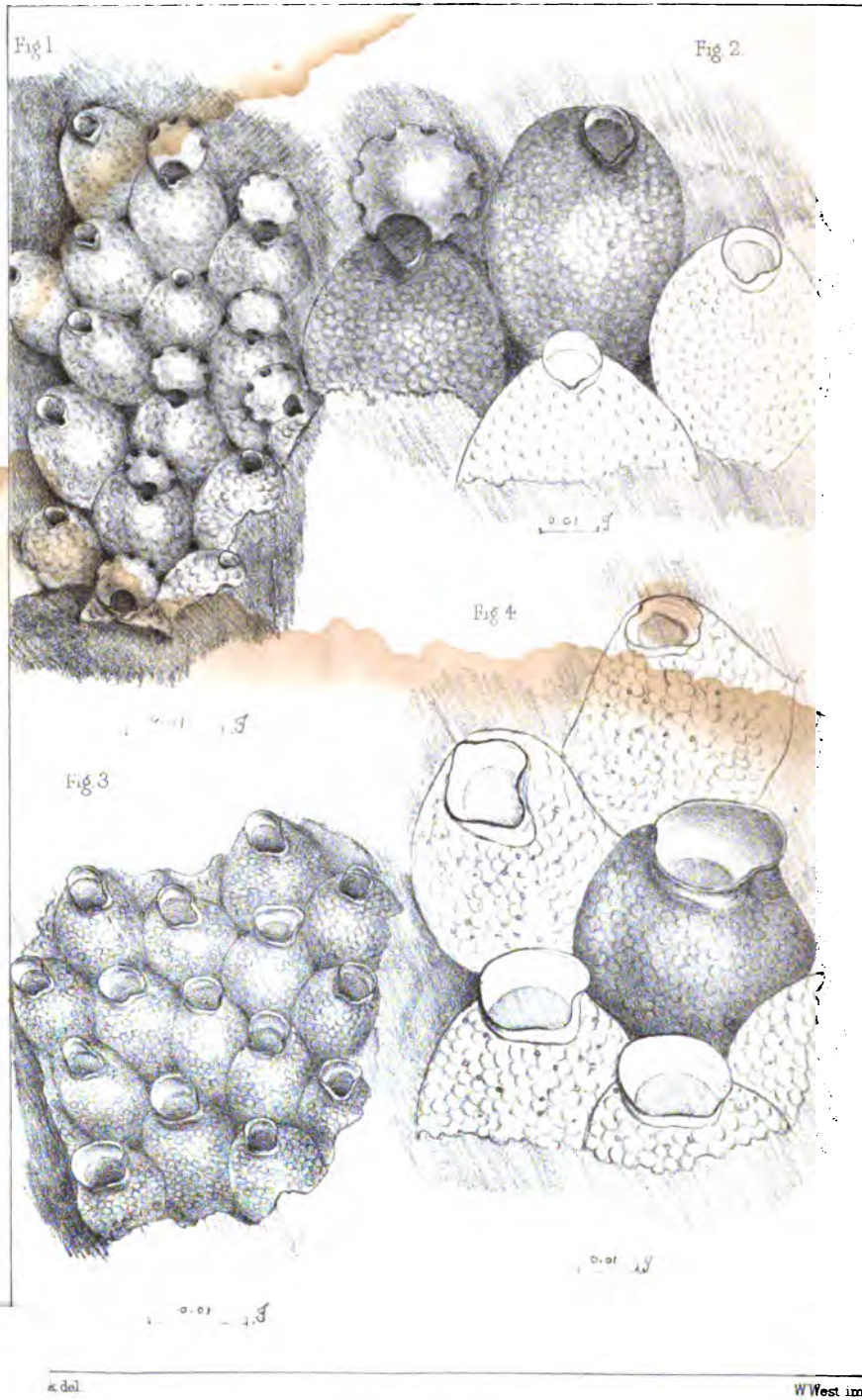


Plate XXVII

Fig 1.

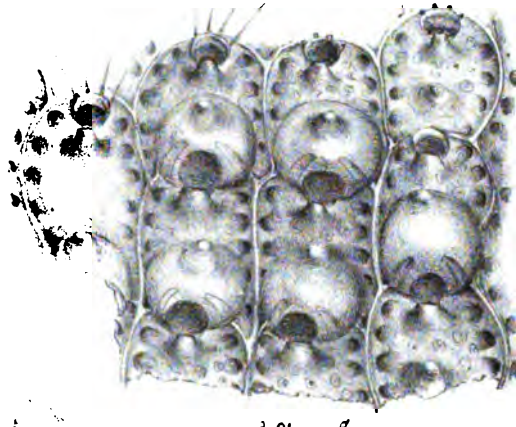


Fig 5

Fig 2

Fig 4

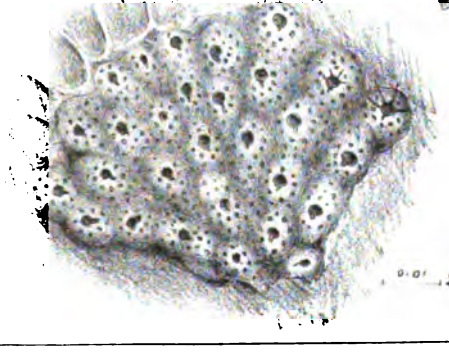


Fig 3

C Busk del

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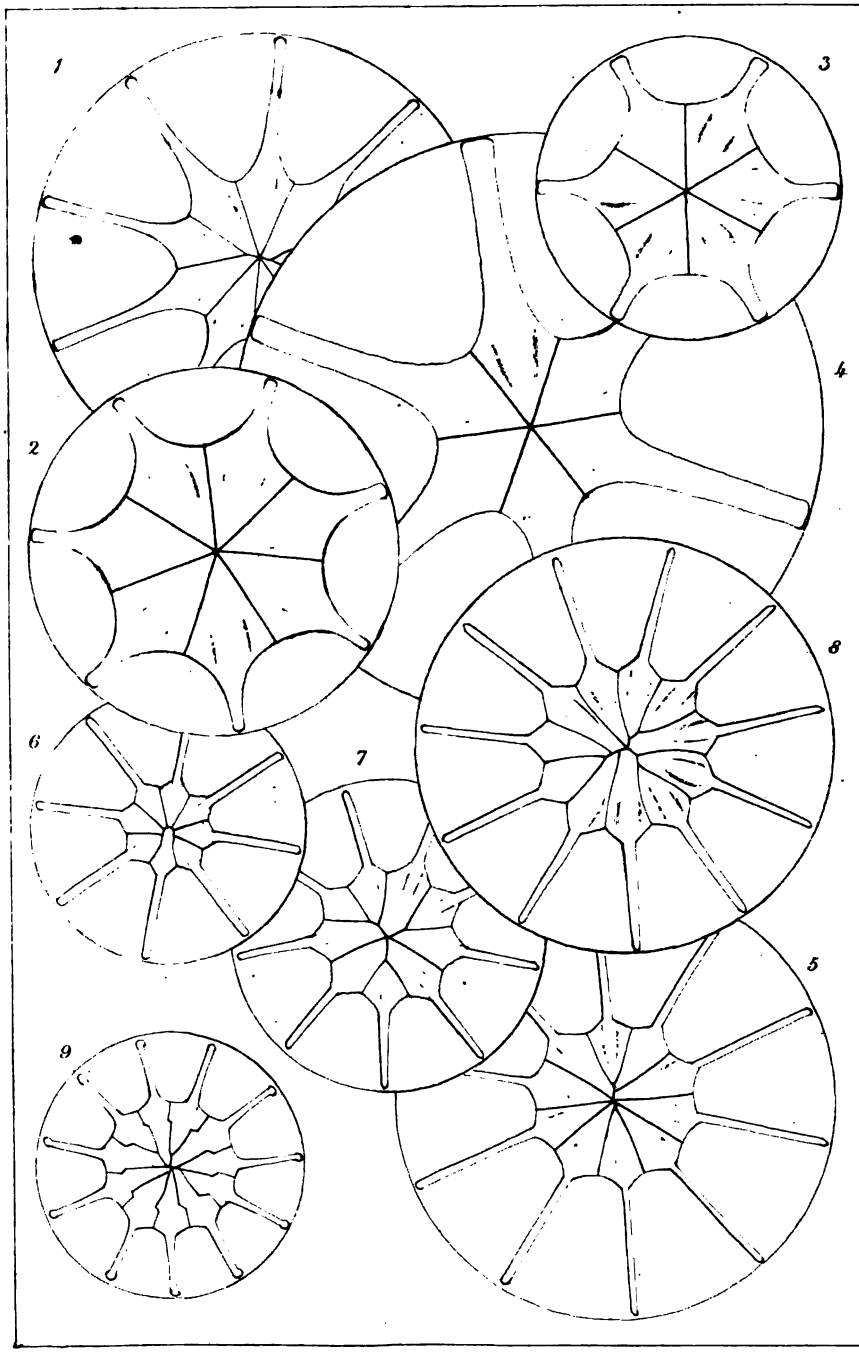

P K G del Tuffen West sc

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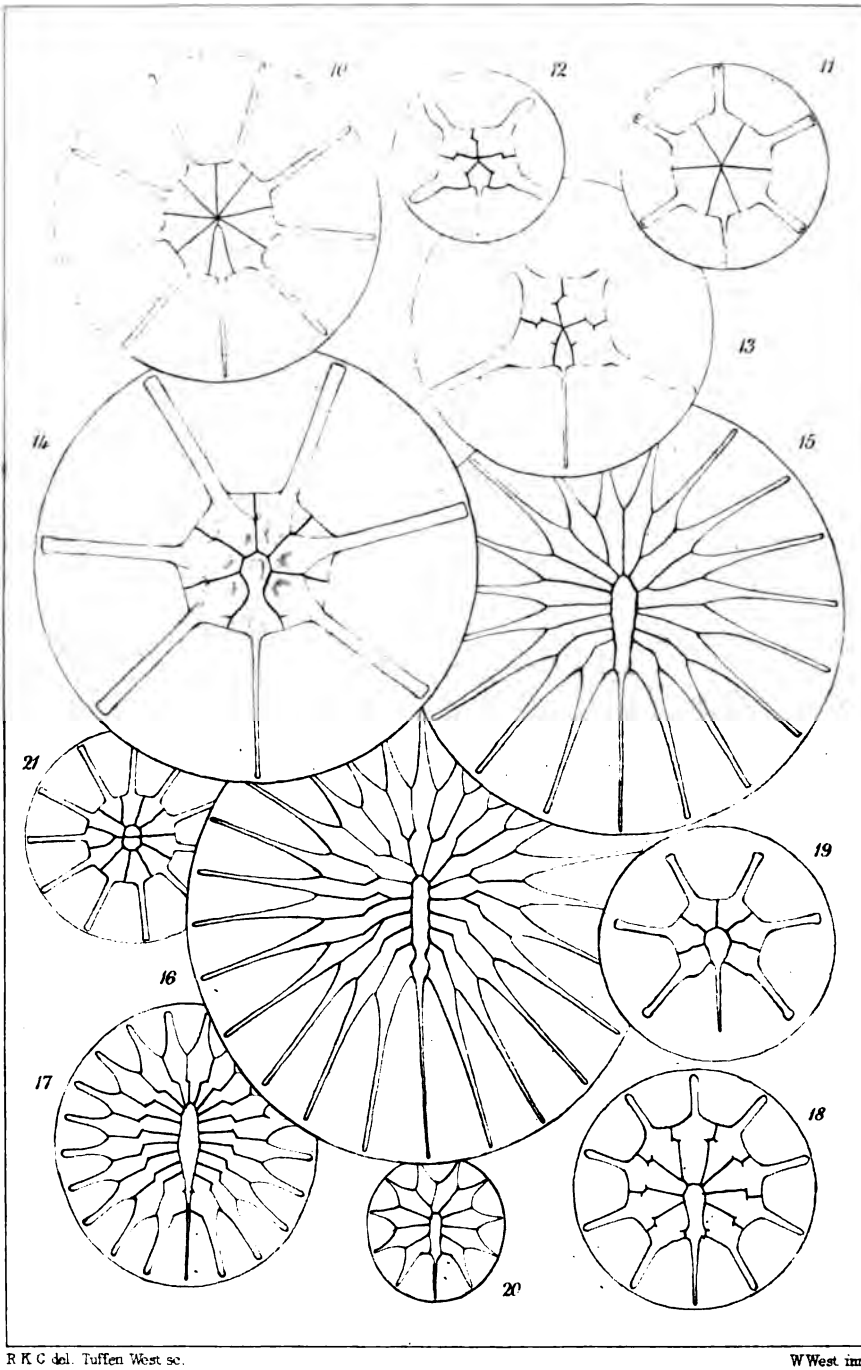


R K C del. Tuffen West sc.

W West imp.

DESCRIPTION OF PLATES III, IV,

Illustrating Dr. Greville's monograph of the Genus *Asterolampra*.

PLATE III.

Fig.

1 to 4.—*Asterolampra Marylandica.*
5.—*A. rotula.*
6 to 8.—*A. variabilis.*
9.—*A. Brébissoniana.*

PLATE IV.

10.—*A. Dallasiana.*
11.—*A. Wallichiana.*
12, 13.—*A. Darwinii.*
14.—*A. Roperiana.*
15.—*A. Hiltoniana.*
16.—*A. elegans.*
17.—*A. imbricata.*
18.—*A. Brookei.*
19.—*A. Shadboltiana.*
20.—*A. stellata.*
21.—*A. Grevillii*, showing an abnormal arrangement of the umbilical lines.

In consequence of an error arising out of the use of a new objective, some of the figures are more than × 400 diameters, but are drawn to the same scale. Fortunately, the range of size in the species is often so very great, the error is not of material importance. The measurements in the descriptions are all × 400 diameters.

Figs. 14, 16, 17, 18, 19 and 20 are × 400 diameters.

As the areolation or cellulation of the segments is essentially similar in all the species, differing only in degree, and often almost imperceptibly so, it has not been considered necessary to add largely to the labour of the engraver, by filling up the segments with so much minute work.

DESCRIPTION OF PLATE V,

Illustrating Professor Allman's paper on the Structure of *Carduella cyathiformis*.

Fig.

1.—A group of *Carduella cyathiformis*, attached to a stone. The left-hand figure represents the animal in a state of contraction.

2.—*Carduella cyathiformis*, outline to show the natural size.

3.—Longitudinal section (semi-diagramatic) of *Carduella cyathiformis*.

4.—Transverse section (semi-diagramatic) of *Carduella cyathiformis*.

The following letters indicate the corresponding parts in figures 3 and 4:

a.—External body-walls or umbrella.

b.—Stomach.

c.—Generative bands.

d.—Vertical lamellæ.

e.—Longitudinal ridges giving attachment to the external edges of the lamellæ, and traversed by a canal.

f.—The four external spaces.

g.—The four internal spaces.

h.—The oral disc.

i.—Circular canal.

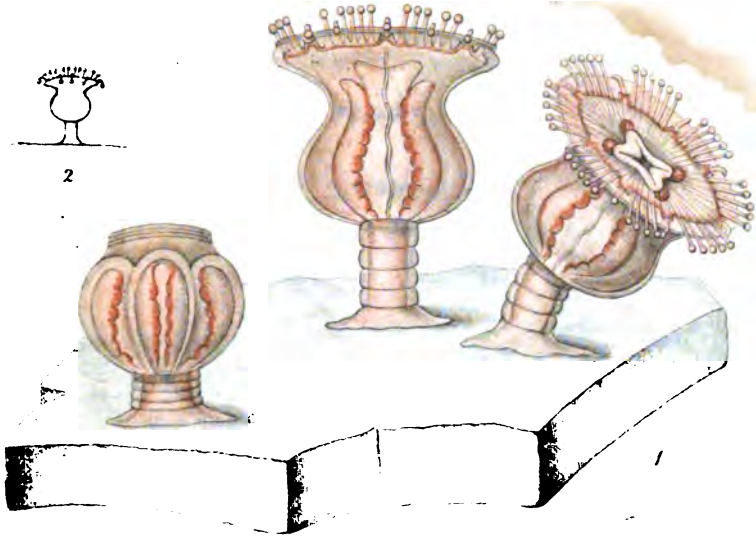
k.—Tubular appendages of stomach.

l.—Sphincter muscle.

m.—Abortive tentacle.

5.—Ovum.

6.—Spermatozoa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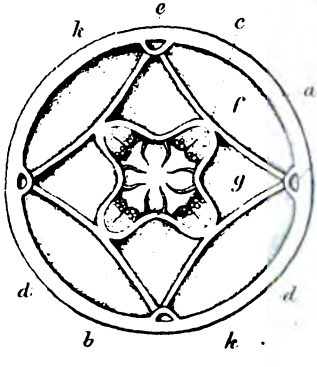
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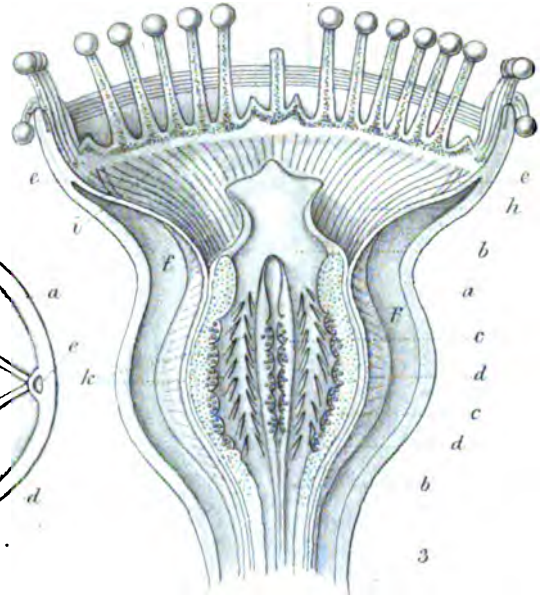
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ORIGINAL COMMUNICATIONS.

On the Employment *of* Transparent Injections *in the* Examination *of the* Minute Structure *of the* Human Pancreas. By Wm. Turner, M.B. (Lond.), Senior Demonstrator of Anatomy, University of Edinburgh.

The investigation of the relations of the minute gland ducts to the ultimate gland follicles in the human pancreas presents considerable difficulties. This is owing, partly, to the great delicacy and transparency of the structures, and partly, because from the close manner in which the minute lobules of the gland are crowded together, it is difficult to obtain a satisfactory view of a single isolated lobule. Thus, the mode of connection of the fine excretory duct of the lobule with the sacculated gland follicles at its extremity cannot clearly be estimated. Moreover, if it is attempted to separate the lobules from each other by tearing them asunder with needles, the relations of the parts become so disturbed, that the examination does not afford any very decided results. For these reasons, it has been customary, in describing the minute structure of this gland, to refer especially to the appearance which it presents in the smaller and more common Rodents, such as the Rat or Mouse.

In these animals the pancreas is spread out in a thin arborescent manner between two layers of peritoneum, so that the different lobules lie mostly on the same plane. Their investigation is on this account comparatively easy, even without the aid of any dissection.*

Being engaged some months ago in making a series of preparations of the human pancreas for the sake of illustrating the structure of this gland to my microscopic class, I [illegible] forcing an injection through the excretory duct [illegible] mate follicles of the gland. I have been enabled [illegible] to obtain, much more satisfactorily than by [illegible] definite views of their relations to each

* 'Cyclopædia,' Article "Pancreas."

other. The injecting fluid which I used was of the same composition as that recommended by Dr. Lionel Beale, and employed by him with such success in his investigations into the minute structure of the liver. It is composed of a mixture of glycerine, spirits of wine, and water, in which Prussian blue, obtained by precipitation, is suspended.

This injection possesses the great advantage of flowing easily when cold along the ducts, and, from its great transparency, the organ into which it is thrown can be examined by transmitted light, and by high magnifying powers, so that the connections and relations of its component structures can be much more readily traced than in those cases where opaque injections are employed. It is hardly possible, however, to make a complete injection of all the ultimate lobules throughout the pancreas; for in many parts they appear to be so filled with secreting cells, and the fine ducts proceeding from them are, in a similar manner, so blocked up with closely packed epithelium, that the injection cannot flow along them. But this does not throw any obstruction in the way of an examination of those lobules into which the injection has passed; it rather tends to facilitate it, for the outline of the ultimate follicles, distended by the blue fluid, comes out more distinctly, by the contrast which it presents to the paler non-injected portions.

It will be frequently found advantageous to examine those lobules, the sacculated follicles of which are only partially filled by the injection; for in them the general and relative arrangement can be more distinctly seen than in those lobules which are completely distended, as in the latter case, owing to the amount of injection in them, a degree of opacity is produced which renders the outline of many of the follicles somewhat indistinct. Most of the sections which I have examined have been made with a Valentin's knife, and the preparations have been soaked for a short time in glycerine, which facilitates the investigation of the pancreas, as of many other animal textures, by increasing the transparency.

The large excretory duct of the pancreas extends along the centre of the gland from head to tail, and is enclosed on all sides by the large lobules. From it, at frequent intervals, smaller ducts proceed, which pass into these large lobules, and in them divide and subdivide into fine branches, for the ultimate lobules. Of these fine branches some arise at right angles, others at a more or less acute angle, and after a very short course they become connected with the ultimate gland follicles of the lobule to which they belong. Each duct, as a general rule, preserves the same calibre from the point at which it commences, to that at

which it either gives off a branch, or terminates in an ultimate lobule. In some instances the ducts possess dilatations on their walls, which may either be confined to one side, or may exist at corresponding points on both sides. The same mode of termination of the fine ducts in the ultimate lobules does not appear to exist in all cases, but admits of slight differences. In some instances the duct passes to the base of the lobule, and then from it, as from a centre, the saccular dilatations of the ultimate follicles spring. In others the duct runs for a short distance along the base of the lobule, giving origin in its course to the follicles, which are connected to its sides and extremity. In either case the fine membrane forming the wall of the duct is continuous with the membrane constituting the wall of the follicles, so that the cavities of the follicles are continuous with that of the duct. The number of follicles present in an ultimate lobule varies considerably in different specimens. There are also great differences in their shape and size. Some are spheroidal, others laterally elongated, so as to present a more or less oval form; others again are more pyriform. When distended by injection, they all present convex, smooth, and well-defined outlines. On account of the general shape of the follicles, and the mode in which they are grouped together in the lobule, they resemble in appearance a bunch of grapes, with which they have frequently been compared.

The epithelial contents of the follicles are of course completely concealed in the injected portions of the gland; but in those lobules into which the injection has not passed, the shape and general arrangement of the secreting epithelium may be conveniently studied. It frequently happens that, in examining sections of the gland, isolated follicles may be seen, lying perhaps closely together, as if they had originally formed parts of the same lobule, but still separated by slight intervals from each other, having probably become detached from their original connections in the act of making the section. (Pl. X, fig. 3.) In these isolated follicles the secreting cells may be generally very distinctly seen. They form a closely packed layer, lining the inner surface of the membrane forming the wall of the follicle. Their shape is spheroidal, so that they form a true glandular epithelium.

Professor Kölliker, in his 'Microscopic Anatomy,' describes the pancreas as belonging to the compound racemose group of glands, of which the salivary glands and the mucous glands of the mouth may be taken as the type. In his description of the last-named glands, he states that the grape-like appearance of the ultimate follicles is owing to the fine ducts being coiled upon themselves, presenting at intervals numerous

simple or compound dilatations or diverticula. He considers the glandular vesicles to be nothing more than these dilatations. In my examination of the injected pancreas, I have not succeeded in sufficiently separating from each other the various follicles making up a lobule, so as to state whether the view of Professor Kölliker can be applied to the pancreas. Whether we hold, however, with the more generally accepted doctrine, that these follicles are saccular dilatations at the extremity of the duct, or with Professor Kölliker that they are produced by a coiling of the duct upon itself, the important fact still remains, that the membrane forming the wall of the follicles is connected with that forming the wall of the duct, and that the cavity of the one is continuous with that of the other.

In this communication I have avoided the use of the term acini, as it has been employed by different observers to express different structures, so that its use is liable to lead to confusion of ideas; some applying the term to express the ultimate lobules of the gland, whilst by others it is used to signify the ultimate follicles of these lobules.

Further Observations *on the* Structure *of* Nerve-Fibres.

By Wm. Turner, M.B. (Lond.), Senior Demonstrator of Anatomy, University of Edinburgh.

In the number of this Journal for October, 1859, appeared a communication by Professor Lister and myself, 'On the Structure of Nerve-Fibres.' In it we directed attention to the great benefits to be derived from the use of chromic acid and carmine in the examination of these fibres. We especially pointed out the different action of these two substances upon the constituent structures of the fibres, the axial cylinders alone being coloured by the carmine, whilst the medullary sheaths assumed under the action of the chromic acid a peculiar fibroid appearance. Our observations were made especially upon transverse sections through the fibres, not only as they exist in an ordinary spinal nerve, such as the sciatic, but also as they lie in the columnar portions of the cord. In addition, we described and figured certain fibres, views of which were obtained by making longitudinal sections of the columnar portions of the cord. Since this paper was printed, I have continued my observations on the subject, and, by a slight modification of our former process,

have succeeded in obtaining extremely satisfactory views of the axial cylinder, and of the proportion which it bears to the medullary sheath. From the great simplicity and precision of this process, I am induced to make the following communication.

Portions of an ordinary spinal nerve, previously hardened by immersion in chromic acid, were placed for a few hours in an ammoniacal solution of carmine. After being removed from this solution, they were washed with water, spread out on a glass plate, and then treated with spirit, turpentine, and Canada balsam in the ordinary way. They were then examined under a good one-fifth inch object-glass in their entire state, without sections being made through them, either in one direction or another, the fibres lying in their natural position parallel to each other.

In the various fibres of the bundle, the axial cylinder was seen to be deeply tinted by the carmine. It could be traced along the centre of the fibre, occupying its middle third, and presenting a perfectly clean and sharply defined outline.

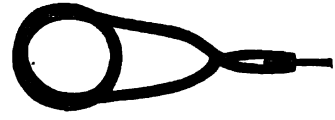
In none of my preparations have I been able to see any of those "ramifications" of the axial cylinder into the medullary sheath, which have been so elaborately figured and described by Stilling.

A careful examination of the numerous figures given by him in the twenty-fourth plate of his great work, and a comparison of these figures with my own preparations, convince me that the structures which he has described under that name are nothing more than small fibroid particles of the medullary sheath itself, and quite distinct structurally from the axial cylinder. If they had been actual prolongations of the axial cylinder, they would, like it, have received the carmine colour, which, so far as I have seen, never takes place.

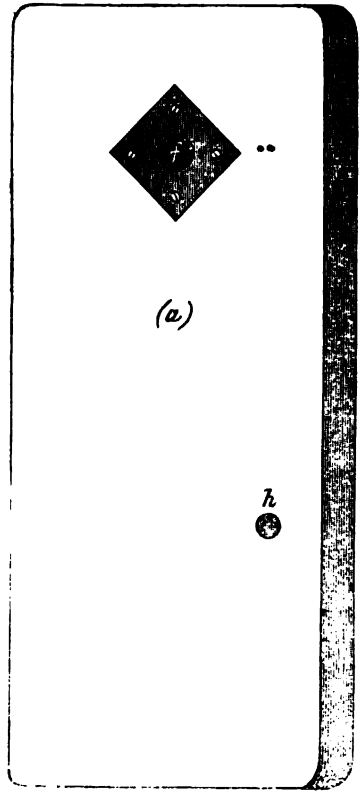
I cannot agree, either, with the opinion expressed by Stilling of the connection of the different fibres in a bundle by means of fine elementary tubules passing between them. Each fibre in my preparations possessed a distinct and well-marked unbroken outline, the only intermediate material that I have seen being an extremely delicate, wavy connective tissue, which, although lying between the fibres, does not in any sense form a part of them. Nerve-fibres, examined in this manner in their entire condition, afford to the observer, in a more satisfactory way than is permitted by any other process with which I am acquainted, a means of arriving at precise conclusions respecting the absolute differences between the axial cylinder and the medullary sheath. In them the almost perfectly homogeneous axis contrasts strongly

cell, and counter-sunk to the diameter and thickness of the cylinder glass.

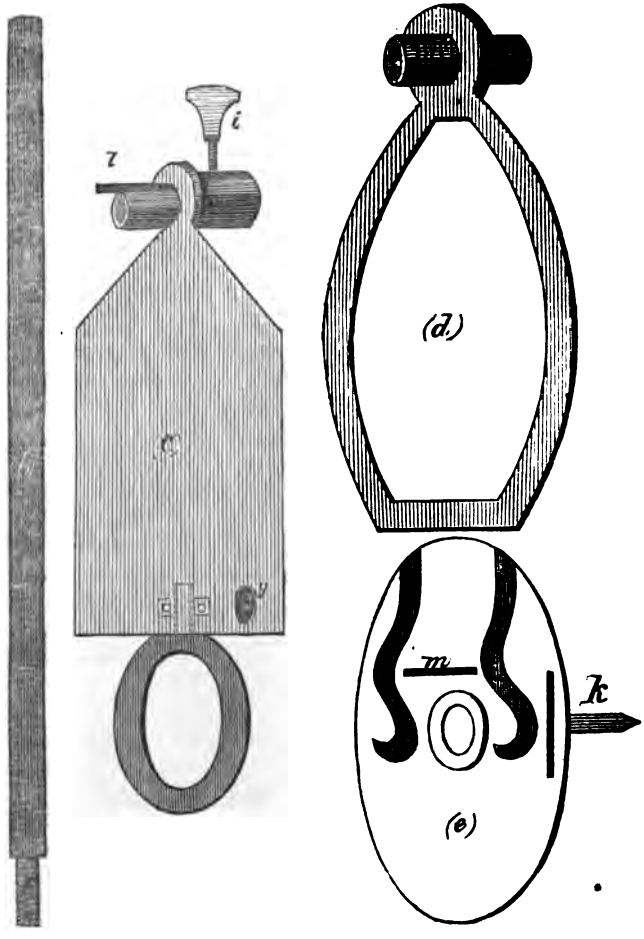
In using this plate I apply sufficient indirect heat to it, and rub over each of the counter-sunk portions some sealing wax or shellac; immediately pressing down into each, upon the softened wax, the thin glass circles. When cold, the centres of each may be easily removed by perforation with a rat-tailed file, and trimmed round with a finer (watchmaker's) file to



the exact diameter of the perforation, the counter-sinking giving the exact centering. The plate may again be heated and the cells slid off into ether, in order to remove the wax and cleanse them. This plate is made with tolerable rapidity and accuracy on a lathe with an eccentric chuck. I have also drawn a description of forceps that I find very useful in preparing microscopic objects, where it is of importance to have gentle pressure, easy of application, with, at the same time, a facility for occasional inspection, as, for instance, in preparing the proboscis of a fly for mounting, and in cases requiring the like treatment. These are almost identical with the forceps used in artificial fly-dressing, but having cemented to their extremities two slips of thin glass, may be brought at any time under the field of the microscope. I have obtained the same result from an American clothes peg, fitted with glass in the same way.



The *microscopic stand and mounting apparatus* has for its object the direct and indirect application of heat; facilities for mounting objects, and also of carrying lenses for dissection *a* represents the stand or pediment, *f* being the receptacle for the screwed end of the upright (*b*) and *h* a sunk portion of brass, in which works the point (*k*) of the shank of *e*. Upon the upright (*b*) is first slid the apparatus for indirect



heat (*c*), and fixed at a convenient height by the milled screw (*i*). The shank (*k*) of (*e*) the "turn-table" is then passed through the perforation of *c* at *g* and its point resting in *h* of the pediment; a rotatory motion may then be given it,

for the purpose either of making varnish cells, or of mounting preparations in fluid, that have been already fixed by hand. A circular ring of brass, of sufficient diameter to hold a watchmaker's or other lens, is also fitted to the under surface of *c*, which may be raised or lowered by the milled head, as required. Over this upon the upright (*b*) slides the apparatus for direct heat (*d*), having two catches to fall on the point (*l*) of *c* and retain it in either direction; *e* is the turn-table before alluded to, having the half and three-quarter circles marked upon it, and also two stops (*m n*), in order that in case of the removal of the slide before the mounting is complete, it may be replaced without causing eccentricity.

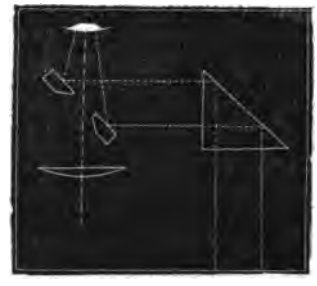
On the Camera Lucida. By M. Nachet, Jun.

In the last number of this journal, Mr. Gray has published some suggestions on the subject of the *Camera lucida*, which lead me to suppose that the various descriptions hitherto given of our camera, to be employed with the microscope in the vertical position, have not been well understood by those who have not seen the instrument. It will not therefore be useless to offer some considerations, in order to show the reasons which have induced us to adopt the arrangement in question. All the forms of camera employed with the microscope in the vertical* or inclined position may be arranged in two classes; the first containing those forms in which the camera gives the image of the object *directly*, and that of the pencil by reflexion; and the second, those, on the other hand, in which the image of the object is given by *reflexion*, and the pencil viewed *directly*. The best instance of a camera belonging to the former category is that of Amici, formed of a perforated steel mirror, and of a prism;† the object being viewed through the opening, *a*, of the mirror, and the pencil reflected by the prism being seen on the annular surface, *c*, *b*. The inconveniences of

* I may here remark that the vertical camera in itself (as a whole) is not, as Mr. Gray thinks, to be despised. Micrographers, who work in earnest, often having to draw objects almost always immersed in fluid, and not having to delay in order to remove a portion, as is done when objects are prepared for preservation.

† The arrangement of this camera has been altered by Chevalier, to adapt it to the horizontal microscope.

this form of instrument arise from the nature itself of the mirror, its easy destruction, and the loss of light.



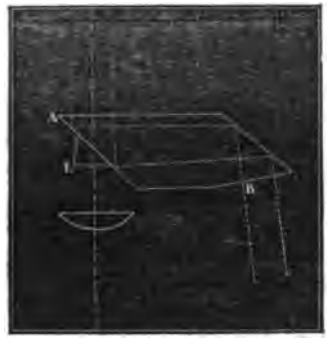
Another instrument of the same class, and which affords very beautiful effects, is the camera of Doyère, which is formed of a very small prism placed above the ocular, and of the reflecting prism of Amici's camera. Its inconveniences are a certain delicacy of construction, and the difficulty of using it; or as observed by Mr. Gray, it is rather difficult to adjust the eye to the angle of a prism.

Nobert conceived the idea of replacing Amici's mirror by an inclined slip of glass; but with this it is difficult to equalize the light between the field and the paper, and the two surfaces of the glass give a double image of the pencil.

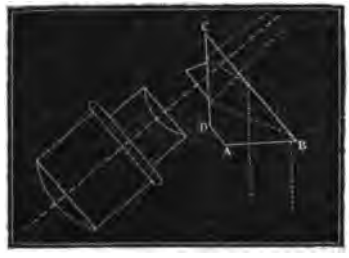
We now come to the second class of cameras, or to those which give the image of the object by reflexion. These, after mature consideration, we are of opinion should be wholly abandoned. They have the grave inconvenience of reversing the image, so that when it is wished to retouch the drawing by the eye after the first sketch, it is requisite to allow for the reversal of the image, without which, the draughtsman is always liable to place what should be above below, and the reverse. Errors of this kind are especially easy to make when the body designed has a rounded or symmetrical contour,—such as embryonic cells, &c. Wollaston's prism, which belongs to the present class, affords, it is true, an image in the same position as that in the microscope, but most often it does not take in the whole field; and besides, in order to use it, the microscope must be nearly horizontal.

The problem to be solved therefore being, that it is required to see first the object, and indirectly the pencil, we have resolved it in the following manner. For the vertical microscope we have adopted the form already described in Dr. Carpenter's work on the microscope. The objections made to its use by Mr. Gray arise from his not having employed it. Thus, with respect to the sensation produced by the appearance of the hand *in the field of vision*, there is nothing disagreeable or annoying in this; but, on the contrary, the motions of the

pencil acquire a resolution and firmness rarely met with in the use of this kind of instrument. Some precautions should be taken in the construction. The angle of the small attached prism, E, should be equal to the angle A, so that the surfaces presented to the eye are well parallel. The surface B should be slightly inclined, so that the pencil may be seen at some distance from the instrument, in order not to come in contact with the stage. The projection of the image is thus rendered a little oblique, but to so very trifling an extent that the deformity is almost inappreciable; and besides, if the paper be a little inclined, this defect is removed.



The arrangement adopted for the inclined microscope is based on the same principle as the foregoing. A prism giving two total reflexions is placed above the ocular, so that the rays coming perpendicularly from the table are reflected by B, C, and then by C, D, so as to issue by the same surface, B, C, which is at the same time a surface of reflexion and of transmission. An image is thus afforded of the object viewed by the small prism E, whilst that of the pencil comes from C, D. It follows that, by this prism, 1st, the image of the pencil appears to be transported into the field of view, and that the object is viewed in its true situation; and 2dly, that the observer, looking into the ocular, enjoys the advantage of the comfortable inclination of the instrument, whilst in the other systems of cameras the inclination of the microscope is without advantage, because it is necessary to look vertically upon the table.



TRANSLATIONS.

The Zoospores *of* Chroolepus, *Ag.**

The first of the plants to which the observations refer is *Chroolepus aureum*, Spr. var. *tomentosum*, Kg. Under the microscope, the plant is seen to be formed of erect threads, intermixed with branched threads, each consisting of a single row of cells. The walls are colourless, but with a glittering appearance. (Pl. IX, fig. 1, *s*.) The apical cell of the threads often has a globular or pulvinate appendage, of a highly refractive nature, furnished with transverse wrinkles, and frequently also with a protuberance at the top. (Figs. 1, 2, 3, 5, 6, 7, 8, 9, *g*.) The whole cavity of the cells is filled with granular matter, mostly of a brownish-red colour; but it frequently happens that the inner granules only are brownish red, whilst the outer ones are green. (Figs. 3, 16, 17, 18.) The reddish-brown granules seem to be oil-drops. Iodine seems to turn them to a dirty blue. From the effect of different reagents, the author considers the cell-wall to be formed of an amylaceous cellulose; the wrinkled apex, on the other hand, of some different substance, probably gelatine. A great number of the threads terminate with a globular, much-thickened cell, which subsequently becomes the mother-cell of the zoospores. (Fig. 3, m.) This mother-cell is rarely found in the middle of the threads. (Fig. 4, m.) Occasionally, but still more rarely, the cell immediately under the mother-cell elongates itself sideways and upwards into a thread. (Fig. 14.) The mother-cell of the zoospores, when it forms the terminal cell of the thread, bears a conical mass of gelatine, often of considerable size (figs. 5, 7, 9, *g*,), which, however, is seldom on the crown of the cell, but usually at its side. (Figs. 3, 5, 7, 9.) In those mother-cells in

* Condensed from the German of Dr. Caspary, in the 'Regensburg Flora,' for September 28, 1858, by F. Currey, Esq., M.A., F.R.S., F.L.S.

which the zoospores are about to escape, a division of the contents into small oval cells is clearly perceptible, (fig. 5), and at the side, or near the top, the wall is extended into a short papilla. (Figs. 5, 7, *p*.) The contents emerge in the form of a well-defined vesicle, with the zoospores, penetrating through the ruptured papilla (figs. 6, *k*, 8, *k*); sometimes, however, no vesicle is formed. A few moments after emerging, the vesicle bursts, doubtless by absorption of water, and the zoospores swim about in every direction. The remnants of the vesicle are of a gelatinous nature. The escape of the zoospores was observed from nine in the morning till four in the afternoon, and seems to depend, not upon the influence of light, but solely upon the effect of moistening with water. The zoospores are very small, 0·0035 to 0·0033 mm. They are filled with reddish-brown granular matter, the apex alone being free and hyaline; there are two cilia, about three or four times as long as the spore. The apex, with the cilia, is directed forwards. They rotate perpetually whilst swimming; their motion being so rapid as to prevent a clear view of them, except when stopped by some obstacle, or when their motion is becoming retarded. When killed by concentrated solution of iodine, or iodide of potash, the zoospores appear brown, with the exception of the apex, which is hyaline as before; the cilia are very little browned, but become more distinct. The cell is surrounded by a clear, highly-refractive border (figs. 10, 11, 12), looking like gelatine, but which may be only an optical appearance. Treated with iodine and diluted sulphuric acid, the whole zoospore, apex and cilia, become deep brown. (Fig. 13.) After continuing in motion for about an hour, the zoospores become sluggish, sink, become globular (fig. 15), elongate themselves (fig. 16, *a*, *b*, *c*), and shortly a division of the cell takes place by a transverse septum. (Figs. 17, *a*, *b*, *c*, *d*.) Some reddish-brown granules usually remain behind in the empty mother-cell, and in the remnant of the vesicle. (Fig. 9, *k*.) Oftentimes some zoospores cannot emerge from the mother-cell, and then they sometimes geminate in it.

Chroolepus umbrinum, Kg.

Chroolepus umbrinum, Kg. 'Phycol. gener.,' 1843, p. 283. 'Rabenhorst Deutsch. Kryptog.,' 1845, ii, 2, 87.

This plant is common about Bonn, on the bark of trees, in the form of a reddish-brown, scentless, thin stratum, principally on the northern side of the tree. The zoospores were

observed in the middle of July, 1856, and in May, 1857; but after the dry and hot spring of 1858, were sought for in vain. They have never been found in the autumn, or late in the summer. In order to find them, it is a good plan to leave a piece of the bark covered with the plant in a damp vasculum for a night. *Chroolepus umbrinum* usually forms solitary globular cells, frequently, however, exhibiting two or three together (figs. 18 and 19), and rarely as many as from four to seven. The gobular or sub-globular cells are 0·0071 to 0·0098 mm. in diameter. The membrane is thick, and consists of cellulose; it is not coloured, however, by iodine, but it becomes of a beautiful blue under iodine and sulphuric acid. (Fig. 20.) The contents consist of small granules, coloured reddish brown by the colouring matter adherent to them; they are turned to a dirty blue by iodine, and consist of starch and of large, reddish-brown, highly refractive oil-drops. Strange to say, the oil-drops are coloured a deep dirty blue by iodine. The zoospores are not so numerous as in *C. aureum*. The mother-cells of the zoospores are somewhat larger than the vegetative cells, but not otherwise distinguishable. The spores are larger than in *C. aureum* (figs. 21 and 22), and 0·0042 to 0·0043 in length. They are oval on one side (fig. 21), but quite flat on the other (fig. 22), and rotate perpetually in swimming. They have a clear border (figs. 21 and 22, *s*) (? substantial or an optical appearance), which remains after treatment with iodine, or with iodine and diluted sulphuric acid. The apex of the zoospores is colourless, the expanded hinder portion being filled with reddish-brown granular matter. They have two cilia at the apex, which are two or three times as long as the cell. When treated with iodine, the apex remains colourless and hyaline; the upper part, however, becomes of a dirty blue colour. (Figs. 25 and 26.) If diluted sulphuric acid is employed after iodine, the whole cell, including the apex and cilia, becomes of a deep brown colour, but a tinge of dirty blue is still visible in the middle of the cell. (Fig. 27.)

The zoospores, therefore, of *Chroolepus umbrinum*, are acted upon by reagents very similarly to those of *C. aureum*, the difference being that the reddish-brown granular contents of *C. umbrinum* are somewhat firmer, whilst the contents of *C. aureum* consist of a substance not coloured blue by iodine. It is particularly worthy of notice, that the hyaline apex of the zoospores of both plants is not rendered brown, but remains colourless under iodine, proving, it would seem, the absence of nitrogenous matter in the covering of the zoospores of Chroolepus, or at least in the apical portion of it. The author was unable to separate the covering from the cell-

contents; and therefore in *Chroolepus aureum*, where the cell-contents are rendered brown by iodine, he cannot say whether the whole of the covering, or only its apex, is unaffected by the iodine. But inasmuch as, in *C. umbrinum*, the zoospore, even after treatment with a strong solution of iodine and iodide of potassium, exhibits, on account of its amylaceous nature, only a dirty blue colour, and not a brown, it seems probable that the whole remaining portion of the cell-covering is of the same nature as its apex, that it is not coloured brown, and consequently is not nitrogenous. From its behaviour under iodine and sulphuric acid, the cell-covering probably does not consist of cellulose, although in the present state of microscopical chemistry it is not easy to say accurately of what it does consist. The observation, however, is an interesting addition to our knowledge of the nature of the covering of zoospores, which covering has hitherto been supposed to be always coloured brown by iodine, and to be therefore nitrogenous. At all events the cell-covering, or at least the apical portion, cannot in Chroolepus be looked upon as a primordial utricle. It would seem that the subsequently formed cellulose membrane of the cells of Chroolepus is present in the zoospores at the period of swarming, but that in this condition the young membrane does not exhibit the consistency or the reactions which are afterwards visible in it. The author then proceeds to observe, that the existence of so peculiar a membrane is less surprising, as there are several other algæ which exhibit unusual chemical peculiarities in their cell-coverings; and after noticing several instances of such algæ, he concludes that there are modifications of cellulose dependent upon the age and the species of the plant, which do not exhibit the usual reactions; and that it is therefore fair to assume that the membrane of the zoospores of Chroolepus, or at least the colourless apex of the membrane, consists, at the period of swarming, of a modification of cellulose not exhibiting the usual reactions, whilst the zoospores of other plants are only clothed with a nitrogenous primordial utricle.

The young membrane of the zoospores of *C. umbrinum* is very delicate, and disappears soon after the death of the zoospores, of which a few only lived to vegetate. The brown granular contents of those which died escaped in all directions (exhibiting active molecular motion) very shortly after the cessation of the motion of the zoospores, showing that the cell-wall did not burst, but dissolved. (See fig. 24.) Fig. 23 shows the remnants of a zoospore, consisting of a heap of granules surrounded by a gelatinous mass (*s*) which belonged to the cell-contents, not to the membrane. Iodine did not

colour these granules blue, but it rendered the cilia visible, the latter appearing to be able to resist dissolution for a longer period than the cell-membrane. The granules had all a border (*s*) around their nucleus (*k*). (See fig. 23, *b*.) The author did not see the zoospores attach themselves to any foreign body; they simply sank. Some of the zoospores of *C. aureum*, which were kept moist under glass, increased by cell-division.

Agardh rightly placed Chroolepus amongst the algæ; he considered it to belong to the Confervoideæ. Kützing, in his 'Phycologia generalis,' placed it with the Chantransiæ, and in his 'Species Algarum,' with the Conferveæ. The author considers the latter its proper place, in juxtaposition with Cladophora.

On Sarcina, *and especially on its occurrence in the* Urine *of* Man. By Dr. Hermann Welcker.

The following is an abstract of Dr. Welcker's communication, which has appeared in Henle and Pfeuffer's 'Zeitsch. f. Rat. Med.,' 3d ser., vol. v, p. 199 (1859).

The most usual situation in which the sarcina occurs is, as is well known, in matters ejected by vomiting from the stomach, and it appears to be a common concomitant of chronic vomiting. It appears, however, to be occasionally present in the stomach, in cases where no symptoms of gastric derangement had existed.

Its occurrence in the urine has been frequently noticed; thrice by Heller, once by Dr. Mackay, twice by Dr. Johnson, and twice also by Dr. Beale.

Notwithstanding the hesitation with which Zenker admits the probability of the occurrence of sarcina in the urinary secretion, no doubt can be entertained, that in the cases about to be detailed, the *Sarcina* originated in the urinary organs themselves, and did not gain admission through any fistulous passage, nor had become accidentally mixed with the urine. But whether the sarcina were confined solely to the bladder, or occurred also in the pelves of the kidneys and *tubuli uriniferi*, must still be left undetermined.

With respect to other situations in which the occurrence of sarcina has been noticed, may be mentioned, in the fæces and intestinal canal, by Bennett and Hasse; in cholera-stools, by Wedl and Mensonides; in the contents of portion of gangrenous strangulated intestine, by Demme; in the bronchia, by Virchow and Friedreich; in the substance of the lungs, by Zenker, Virchow, and Demme; in the fluid of the cerebral ventricles, but under doubtful circumstances, by Jenner.* In animals, it has been found by Virchow in the stomach of the rabbit, and in that of the dog by Frerichs; whilst, more lately, Eberth has found it in the intestine of the ape, and in the cæcum of the common fowl, &c.

No specific distinction has hitherto been drawn between the kinds of *Sarcina* derived from these various localities, although diversities in the size and colour of the corpuscles have been incidentally noticed.

The case in which I observed the occurrence of *Sarcina* in the urine, was that of a medical man, forty-seven years old, who had been ailing for some years, and was consequently somewhat emaciated, and had lost much strength. He suffered much from nervous excitability and depression of spirits, and entertained a vague suspicion that he was labouring under some renal affection, even before the discovery of the sarcina in his urine. He never vomited, and there was no evidence of the existence of *Sarcina* in the stomach.

I first examined the urine on the 1st, 2d, and 5th July, 1857. It was strongly acid, and very shortly after its emission presented, when contained in a test-tube three fourths of an inch in diameter, a light-whitish cloudiness. This, when the fluid was closely examined by the naked eye, by transmitted light, was seen to be caused by the presence of very minute grayish-white corpuscles, which microscopic examination proved to be nothing but sarcina. At the end of about an hour these corpuscles had subsided, and formed a grayish-white, light sediment, occupying about one tenth of the length of the tube.

In the urine just passed into a perfectly clean glass, the microscope detected—

1. Very numerous specimens of sarcina.
2. Crystals of oxalate of lime.

* To these instances may be added two or three in which the occurrence of *Sarcina* was noticed by ourselves in the contents of the stomach—especially in one remarkable case of rupture of the diaphragm, in which the stomach was forced into the left side of the thorax, and became distended with an enormous quantity of brown grumous fluid, consisting almost entirely of *Sarcina ventriculi*. [G. B.]

3. A few pus- or mucus-corpuscles, and some traces of epithelium (but no fibrinous casts, and the urine was never albuminous).

As nearly as could be estimated, the Sarcina constituted 95, the crystals 4, and the other corpuscles 1 per cent. of the morphological elements in the urine .

The *Sarcina* presented the following diversities of form in the corpuscles:

1. Isolated cells, 0·0010 to 0·0018 mm. in diameter, which, although, on the whole, of a rounded form, in larger specimens were more angular and cubical. That these were really sarcina-cells, elements of the cubes to be presently described, is shown, in the first place, by their size, which much exceeded that of colourless blood-corpuscles or pus-cells. On the application of acetic acid also, no nucleus was rendered apparent in the sarcina-cells, as in the bodies just mentioned; whilst iodine produced in them the same yellowish-brown colour as in the entire sarcina-cubes.

2. Cubical masses, exhibiting on each face four cells, and which consisted therefore of eight cells. The sides of the smaller of these cubes measured 0·0020 mm., and of the largest 0·0027 mm.

3. Cubes with four cells on each side, that is to say, constituted of sixteen cells in each face, and consequently forming packets of sixty-four cells. Each side of these cubes was 0·0042 mm. to 0·0052 mm. long. Larger cubes than these were never observed in the urine. On the other hand, in some specimens of the sixty-four celled packets, it might very readily be seen that these bodies were to some extent not mathematical cubes. In these instances the face presented to the observer was for the most part an oblong, 0·0052 mm. in length, and 0·0050 mm. in breadth. The illuminated cross, constituted of two lines bisecting each other in the middle, and by which the sixteen cells are divided into four groups, exhibited in these cases a longer and shorter limb; a condition which probably indicates the first line of fissure of the entire bundle. Lastly, the urine presented:

4. Columnar sarcina-masses, 0·0050 mm. long, 0·0025 mm. broad, and exhibiting on the four larger faces eight, and in the two smaller four, and consequently, in the whole, sixteen cells. These masses, in all probability, arise from the division of the sixty-four cell bundles.

By far the majority of the sarcina-masses in the urine belonged to the second and third forms, that is to say, were cubes composed of eight or of sixty-four cells.

It at once occurred to me that the sarcina-masses ejected from the stomach are of far larger dimensions than those just

described. With respect to this, I am able to avail myself of six observations of *Sarcina ventriculi*, as affording materials for measurement; and, in the following table, I give their mean dimensions in these instances, with those of the sarcina in the case I am describing, placed opposite each other:

	URINE.	STOMACH.
Primitive cell . . .	0·0012 mm.	0·0025 mm.
Cube of 8 cells . .	0·0023 mm.	0·0050 mm.
„ of 64 „ . .	0·0048 mm.	0·0100 mm.
„ of 512 „ . .	none.	0·0200 mm.
„ of 4096 „ . .	none.	0·0400 mm.

With respect to the measurements given by various authors of the *Sarcina* met with in the stomach and intestinal canal, they appear, when allowance is made for the different modes in which they have been made, to show sufficiently well that the objects described by these authors are, as regards their dimensions, identical with those placed in the second column of the above table, but not with the urine sarcina.

It appears to me, therefore, that we have to do with two distinct species. The sarcina of the urine is, in all respects, smaller than that ejected from the stomach. Cubes containing 512 cells do not appear to occur in the urine; and whilst the stomach-sarcina consists chiefly of bundles constituted of 512 and 4,096 cells, in that form which occurs in the urine, the bundles, when the number of cells reaches sixty-four, break up into their elements, which separate and represent new, isolated individuals.

It would be interesting to inquire, whether in the sarcina previously observed in the urine, the dimensions were as small as in the preceding instance; but to determine this no materials exist.

That the early disintegration of the *Sarcina urinæ*, as well as the smallness of its cells, are merely accidental and dependent upon the condition under which it exists, and that, if introduced into the stomach, it would reach the same size, appears to me hardly probable.

The determination of the question, whether the sarcina of the urine be a distinct species, or, at any rate, a variety of the common sarcina, is not without interest; and I much regret that no opportunity, owing to the unexpected de-

parture of the patient, was afforded for further experiments than those I shall now mention, for its determination.

The author then proceeds to detail some experiments, in which he injected some of the urine, containing sarcina, into the bladder of a rabbit and of a dog, without any result. Its introduction also into the stomach of the former animal, with its food, was also unattended with any result; no trace of the sarcina being found in either case, either in the urine during life, or in the organs after death.

Some observations are then made on the mode of *development* and systematic position of the Sarcina; but, as these do not appear to contain anything of importance, we pass them over, and conclude with the following list of queries, which are suggested by Dr. Welcker, as demanding attention.

1. Does the *Sarcina urinæ* always exhibit the small dimensions above indicated, of the isolated cells, as well as of the entire bundle?

2. Has the *Sarcina* found in other situations also, as in the lungs, for instance, the same or very similar characters?

3. Is the transplantation of *Sarcina urinæ* into the stomach always without result? Or, does it, under these circumstances, retain its peculiar characters, or assume those of *Sarcina ventriculi?*

4. What is the result of the introduction of *Sarcina ventriculi* into the urinary bladder?

5. Is *Sarcina urinæ* never, or at any rate so rarely accompanied by *Sarcina ventriculi*, that even in this respect the two forms appear to be independent of each other?

6. Is the urinary bladder the only habitat of *Sarcina urinæ;* or, is it also to be found in the pelvis of the kidney and the *tubuli uriniferi?*

7. Is the presence of sarcina in the urine accompanied with any special morbid condition of the uro-genital system?

8. In case the last question should be answered in the affirmative, in what way does the infection with *Sarcina urinæ* take place?

9. What means have we, and especially by injection, for the destruction of the *Sarcina?*

On the Mature Condition *of* Trichina spiralis. By Dr. Rudolph Leuckart.

Some months since I communicated to my friend, Professor Van Beneden, at Louvain, the results of a helminthological experiment, which appeared to establish the connexion of *Trichina* with *Trichocephalus*, already supposed to exist by Meissner, Küchenmeister, and others. In this experiment, I fed a young pig with a quantity of trichinised flesh, for which I had been indebted to the kindness of Professor Nasse of Marburg; and on dissection, after the lapse of four weeks, I discovered in the large intestine a very considerable number of *Trichocephalus dispar*, probably thirty or forty specimens, some of which were in a state of perfect sexual maturity, and some nearly in that condition.

Professor Van Beneden communicated the result of this experiment to M. Milne-Edwards, who regarded it of such importance that he considered it worthy of a brief notice before the Academy of Sciences in Paris.

Shortly afterwards a letter from Professor Virchow was read in the same place, in which it was stated that in the intestine of a dog fed with flesh containing *Trichina*, at the end of four days a vast number of minute free vermiculi were found, which were manifestly sexually mature *Trichinæ*, or which, at any rate, were in a condition approaching maturity. With respect to the ultimate destiny of these vermiculi the observer remained in doubt, not regarding it as altogether impossible that they might become *Trichocephali*; he was, however, more inclined to assume that they had some relation to *Strongylus*.

I must confess that on reading this letter I suspected some error on Virchow's part, chiefly because, according to all existing experience, it appeared incredible that a previously asexual worm (for such is the *Trichina*, although already presenting the rudiments of a sexual organ) should, so early as on the fourth day after importation, "be found to contain fully developed ova."

But I must hasten to retract this supposition of error, as totally unfounded.

According to my present researches, there can be no doubt that Virchow is perfectly right. *Trichina spiralis, in the intestine of the* dog, *assumes, in a very short time, the condition of sexual maturity, but independently of a previous transformation into any already known form of thread worm.*

A short time since I obtained from Professor Welcker, of

Halle, a large quantity of human flesh, containing a great abundance of *Trichina*. With this I fed a number of puppies and two young pigs; and examined one of the former on the fourth, and one on the seventh day afterwards. In both I found innumerable free *Trichinæ*, which, however, in the first case were intermixed with others still in the encysted condition. The free worms were full grown. In the second dog some of them were 3 mm. (about $\frac{1}{9}$ inch) long, and, at any rate in that animal, were all sexually mature.

As I do not intend, on this occasion, to give a complete account of my observations, it will be sufficient to say a few words respecting these mature *Trichinæ*.

The females were by far the more numerous, being in proportion to the males, perhaps, as forty to one. They were found between the villi of the intestine, as well as in the intestinal mucus and in the fæces; in the colon, cæcum, and second half of the small intestine, but especially in the former situations, in such numbers, that in a portion of mucus, or of mucous membrane, about the dimensions of a lentil bean there would be found, on the average, from six to ten specimens.

Of the organs in the female body, the uterus is by far the most considerable. It is a simple, very thick canal, occupying in the posterior half of the worm nearly the entire cavity of the body, and opening with a constricted neck at the posterior border of the anterior fourth. Its contents consist of ova of comparatively very large size, and exhibiting all stages of segmentation and embryonic development. The female *Trichinæ are viviparous nematodes*, whose embryos are of disproportionate length. The number of ova and embryos in the largest specimens (the smaller, for the most part, contain none) may be estimated at about a hundred or more.

With the exception of this uterus and their size, the mature *Trichinæ* differ in no respect from the well-known *T. spiralis*.

The male *Trichinæ* are smaller than the female, rarely measuring more than 2 mm. (about 0·1 inch) in length.

This deficiency in length is referrible more particularly to the posterior half of the body, beginning at the commencement of the chyle-stomach, and constituting the portion in which are included, besides the stomach, the simple tubular testes, containing innumerable very minute spermatic corpuscles (which might also be perceived in the genital tube of the female). The opening of the testis is placed at the hinder extremity of the body, immediately in front of the anus. This extremity of the worm is not curved, but, on the other hand, is characterised by the presence of two short

conical eminences placed on either side of the genital orifice, and much resembling the well-known conformation of the genus *Protecosacter*. *Spiculæ* are everywhere present, but of extreme delicacy.

The Trichinæ above described are, as is obvious at a glance (and as is shown more especially by the presence of the embryos in the female), *full-grown*. Moreover, there can be no doubt that they do not undergo any further metamorphosis (into *Trichocephalus* or *Strongylus*, &c.)

Notwithstanding the vast numbers in which they occurred in the animals examined, and in which they must exist in other cases, these nematodes have hitherto escaped the notice of helminthologists. The generic appellation of *Trichina* might be retained for them, although the specific term "*spiralis*" is hardly applicable to the fully developed worm.

In what way man becomes infected with the embryos of this *Trichina* I shall not here describe in detail. That he derives his *Trichina*, like the Echinococcus, from the *Dog*, can scarcely be doubted. I will in addition merely remark that I have, perhaps superfluously, instituted an experiment in elucidation of this point, having administered to a young pig the intestine of the last-mentioned dog, with its contents. We know that the *Trichina* in the encysted condition also occurs in the Pig; the experiment consequently may be expected to prove successful.

Under these circumstances I shall probably have an opportunity of communicating further observations on the subject.

A third dog, which was examined twelve days after feeding, afforded only a few *Trichinæ, which differed in no respect from the preceding*. They were found exclusively in the colon—a circumstance inducing the belief that the mature *Trichina*, notwithstanding the abundance in which it is at first found, nevertheless remains only a short time in its nest. And it may also be stated, that in previous experiments, in animals examined *some weeks after feeding*, no vestige of *Trichina* was ever met with.

The pigs referred to are still alive, and have in the meanwhile served for experiments of another kind. Their fæces, on the sixth day after the feeding, contained *no* Trichina.

[The further results of Professor Leuckart's observations on *Trichina* are communicated in the 'Göttinger Nachrichten' for April 30th, and may be thus briefly summed up.]

That the *Trichina spiralis*, as met with in the muscular tissue, represents the immature condition of a nematoid

worm, which becomes fully developed in the intestinal canal of many warm-blooded animals, both mammalia and birds; amongst which are enumerated the dog, cat, pig, sheep, mouse, man, and the common fowl. The *Trichina* attains full sexual maturity in about two days after its introduction into the intestine. It is viviparous, and the minute filaria-form embryos which are produced in about six days more, immediately commence their migration by penetrating the walls of the intestine, in order to reach the striped muscular tissue. The greater part of the embryos remain in the muscles immediately surrounding the visceral cavities. They make their way through the intermuscular connective tissue, but ultimately penetrate into the interior of the muscular fasciculi, where they reach, in about fourteen days, the size and assume the structure of the well-known *Trichina spiralis*. It would appear also that the immigration of the young *Trichinæ* in great numbers may cause very serious symptoms, either from peritonitis caused by their passage through the walls of the intestine, or great debility in consequence of the disintegration of the muscular tissue.

On the frequent Occurrence *of* Vegetable Parasites *in the* Hard Tissues *of the* Lower Animals. By Prof. A. Kölliker.

(Abstracted from the 'Zeitsch. f. Wiss. Zoolog.,' vol. x, p. 215; 1859.)

In examining the scales of *Beryx ornatus*, Ag., from the chalk formation in England, I noticed peculiar tubular structures, presenting an elegant stelliform figure, of which I was at first at a loss what to make. Their similarity in form to pigment-cells led me at first to think they might be of that nature, but this idea was abandoned when I found that the structures in question occurred not merely in the external layers of the scales, but in the interior as well. At the same time I was unable to entertain any other supposition, since the structure exhibited no points of resemblance with any of the known forms of tubular and cellular structures of bones and scales.

Shortly afterwards, on proceeding to the investigation of the skeleton of the stony Corals and Sponges, I was again struck with the occurrence of curious elongated, delicate systems of canals, the further examination of which soon opened my eyes, and finally led to the conviction that in all those cases the appearances were due simply to the presence

of vegetable parasites in the interior of the hard tissues under examination.

I was at once reminded of the observations of Bowerbank, Carpenter, Rose, and Claparède, respecting the occurrence of peculiar tubes in the shells of Lamellibranchs, and of *Neritina*, and in fossil fish-scales; and which tubes had also been regarded by the two last-named authors, as of parasitic origin. I found also, on comparison with the preparations of shell for which I have been indebted to Dr. Carpenter, that the canals observable in them also belonged to the same category.

These circumstances, and further investigation, carried as far as I was able, gradually opened up a wide circle of facts and appearances, at any rate of such importance as to induce me not to delay their publication, though still incomplete.

First and foremost, it is in any case, physiologically, a circumstance of no little interest, to learn that even such hard and compact structures as corals, shells, the scales of fish, and horny skeletons of sponges are bored and frequently pervaded in an incredible manner by lower forms of plants; in fact, as I would at once remark, by *fungi*. And here the question—not easily to be answered—arises as to the means by which these organisms are enabled to remove or displace the carbonate of lime and the organic substance of the tissues thus invaded. But besides this, the correct knowledge of these phenomena is of importance to zoologists, who would thus be protected from great errors in the explanation of the structural conditions of the hard tissues in question. It is well known that Carpenter, under the term "tubular structures," has designated as a special histological formation in bivalve shells, those portions which contain tubuli—a notion which has obtained pretty general acceptance, and which has been combated by no one (vid. Quekett, 'Histol. Catalogue,' vol. i; Leydig, 'Lehrb. d. Histol.,' p. 108; Siebold, 'Comp. Anat.'), and which I have myself also adopted in my memoir upon "Pore-canals and Cell-secretions," at least as respects certain genera. At the same time, however, I have always excepted the horizontally spreading and anastomosing systems of tubes, with respect to whose true nature I have invariably reserved any expression of opinion. But it is now clear, that when the parasitic nature of certain systems of canals in shells is established, as is actually the case, the occurrence of a true "tubular structure" is at once brought into question; and the same may be said also with respect to the allied conditions in other hard tissues. With regard to the tubuli in the skeleton of the stony corals, seen, so far as I

know, only by Quekett, I myself at first regarded these as a peculiar plasmatic canal-system, and congratulated myself upon being able to add something to the knowledge of the organization of this skeleton, until further investigation taught me better.

From Dr. Bowerbank I have received sponges infested with fungi, with the statement that these sponges exhibited a special tubular system. As regards Rose and Claparède, these authors, although they conjecture the foreign nature of the tubes in fish-scales and shells of *Neritina*, were not in a position to express any definite opinion regarding their nature and origin. If to this it be added, that systems of tubuli, whose nature is not so easily explained, are met with in several other tissues besides those already mentioned, as in the chitinous structures of the Articulata, in the axis of *Virgularia*, in the hard tissues of the Echinodermata, the scales and bones of living Ganoid fishes, it is obvious that a careful comparison and investigation of these conditions is an indispensable and important zoological problem.*

With these preliminary remarks, I will now proceed to give an account of the special observations I have made.

1. Sponges.

During my last stay in England, in the spring of 1859, I obtained, through the kindness of Dr. Bowerbank, a series of sponges, amongst which were two having tubular structures in a horny skeleton. The more marked one of these was described by Dr. Bowerbank as a "sponge from Australia, nearly allied to the fossil genus *Choanites*;" and he added, that "it presented a peculiar form of horny skeleton, whose fibres are covered with a network of tubules." The close investigation of this sponge afforded the following results.

The skeleton of the sponge itself, to judge from the small fragment at my disposal, was wholly composed of a network of the well-known yellowish, horny fibres, as they are termed, which presented no peculiarity, except that the fibres were of very various dimensions. Whilst the smaller

* Since the above was written, I have received a work by Weld, "On the Nature of the Canals which exist in the Shells of several Acephala and Gasteropoda," contained in the 'Sitz. bericht. d. Wien. Akad.,' Bd. xxiii, p. 451, 1859. Wedl communicated his observations to the Academy on the 14th October, 1858, and they consequently have precedence of mine; but as they refer only to two divisions of the lower animals, I still regard the publication of my researches as not superfluous, and the more so because, in the explanation of the nature of the parasites, I am not wholly in accord with Wedl.

fibres, besides the fungoid structures, presented no other elements, in the larger might be observed a certain number of silicious spiculæ, some of which were simple elongated needles with a club-shaped, thickened end at one extremity; some in the form of a trident, and disposed sometimes heaped together in the axis of the fibre, sometimes with their points projecting more or less above its surface.

Now, with respect to the vegetable parasite, this growth is visible, in my specimen, on all the fibres, without exception, in the greatest profusion. (Pl. VIII, fig. 1.) It is a unicellular *fungus*, whose filaments measure, for the most part, between 0·001‴ and 0·002‴; and, in my dried preparations, all contain air, which renders it very easy to trace them. But even when the air is expelled by water or hydrochloric acid, they are still very readily seen; whilst glycerine and balsam render them so indistinct that, at any rate, all the ramifications are not well shown. As regards their disposition and course, in general two kinds of filaments may be distinguished; a deeper set, which are longer and straighter, and a superficial, which are much branched. The former, usually of rather larger size, run in a straight or slightly serpentine course, sometimes in the axis of the horny fibre, though, in the thicker fibres, on the outside of the spiculæ there assembled, but sometimes, at any rate, at a certain distance from the surface. They ramify but very sparingly, except that they give off a good many branches, which proceed to the surface of the fibre at a right angle. Occasionally, however, in preparations well filled with air, I have noticed tubuli furnished with ramuscules running out to a fine point, frequently assembled into bundles, and so numerous, as to give the tubule from which they spring the appearance of the stem of a rose. Widely different was the habit of the superficial filaments which exist in such abundance in the outermost layers of the horny fibres, as to afford, when the surface is brought into focus, the appearance, as stated by Bowerbank, as if the filaments were surrounded with a network of tubules. When these filaments are examined more closely, it will be seen that they are prolongations from the inner filaments, and are sometimes richly branched, and sometimes also anastomosing. The branches are, for the most part, spread out horizontally; and it is these, as I think I have certainly convinced myself, which, in some cases, are connected together; a condition which, it is well known, is observed in the mycelium of various *fungi*. But, besides these, numerous very short offsets arise from the superficial filaments, most of which proceed directly outwards, and appear, in fact,

to open on the surface of the horny fibre. At any rate, there may often be perceived on the fibres, when viewed on the surface, and in side-views, pretty distinct openings; and moreover, especially on the addition of acid, the air always escapes from the fungus filaments at certain determinate spots.

My justification, in regarding all the above-described filaments as belonging to a fungus, lies in the circumstance that I have succeeded in demonstrating, together with them, the existence of numerous *sporangia*. (Figs. 2, 3.) The fertile filaments are, as it seems to me, all, or the majority of them, short ramuscules of the superficial network, passing inwards, and supporting at the extremity rounded sporangia, from 0·91‴ to 0·015‴ in size, and when viewed on the side, of a hemispherical form. The minute structure of these bodies could not be ascertained, owing to the appearances being obscured by the air among the spores. Even when the air was expelled by means of balsam, little was gained, inasmuch as the transparency of the whole was then too great to allow anything to be seen beyond an indistinctly areolar substance. In a good many sporangia the spores were in a germinating condition, and not unfrequently presented delicate branching figures.

A second sponge also given to me by Dr. Bowerbank, and described by him as "a true sponge with tubuli in the fibres," has a horny skeleton without spicules, and numerous anastomosing fibres pretty nearly all of the same diameter. The fungus-filaments in this sponge are found by no means in all the fibres of the skeleton, entire portions occurring wholly free from them; an important fact, inasmuch as in this case the adventitious nature of the enclosed tubuli is not shown by the same decided proof as in the former instance, viz., by the presence of sporangia, none of which were met with. The constitution, however, of the tubuli was in this case such, that even had they existed in all the horny fibres, I should not have hesitated in referring them to fungus-filaments. They present the appearance of rather wide canals, usually in the number of 1, 2, 3, rarely more, penetrating into the interior of the horny fibres, and giving off in their course, at an acute angle, rather numerous branches, which also continue to run in a longitudinal direction. It is peculiar that all these principal trunks give off, at right angles, a greater or less, and sometimes a very considerable number of ramuscules, which run straight to the surface of the fibre, where most of them open externally, as may be plainly seen by the escape, in dried specimens, of the air contained in the filaments. I could perceive no trace of *sporangia* within the

horny fibres, but on their *exterior*, in a few instances, opaque rounded bodies were seated, which were probably *sporangia*, but this I was unable definitively to determine. It was remarkable also that in many places the fungus-filaments presented large, sinuous, elongated dilatations which occupied nearly the whole thickness of the fibre.

2. Polythalamia.

The close examination of a considerable number of sections of Polythalamia, for which I have been indebted to the kindness of my friend Dr. Carpenter, afforded the definite result that in these delicate organisms also a parasitic vegetation is not wanting. Owing, moreover, to the circumstance that in certain of these creatures the shells, also typically contain special systems of tubuli, it is often extremely difficult to decide as to the true nature of the tubuli. The genera in which vegetable parasites, which I also look upon as *fungi*, have been noticed, are the following:

1. Operculina. (Fig. 7.)

In the shells of this genus Dr. Carpenter has described two kinds of tubes, the one fine and closely placed, which run vertically and unbranched, in the upper and lower walls of the chambers, and the other usually constituted of somewhat larger anastomosing canals, which are found in the marginal layer of the shell, whence they penetrate into the vertical dissepiments of the chambers. That the former represent a normal structure does not admit of the least doubt, but with respect to the others any decision is rendered very difficult owing to the circumstance that, together with them, very numerous parasitic structures certainly occur. One circumstance, however, may be noticed which throws light upon the matter; the fact, namely, that in certain individuals the parasites are entirely absent, and that there are genera possessing essentially similar structural conditions, which also exhibit nothing of the sort. Of six preparations of *Operculina*, parasites appear to be entirely absent in five, whilst in the sixth they occur in enormous quantity. Two preparations of the allied *Cycloclypeus Australis* present no structures whatever of the parasitic kind, and the same was the case in four sections of *Nonionina Germanica*. It was thus definitively proved that the second system of tubuli noticed by Carpenter in the species is, as it is described and figured by that naturalist, typical.

Now with respect to the parasitic fungi which were met with in the one specimen of *Operculina*, they were found, in

the first place, in the dissepiments, accompanying and running among the larger tubuli of Carpenter, but secondly, also among the finer tubuli in the thick walls of the chambers. They everywhere presented the aspect of more or less sinuous, irregular, branching, and also frequently anastomosing tubes. But whilst in the former situation the canals were rather wide, so as to measure even 0·002‴ to 0·003‴ and more in diameter; in the latter, fine tubuli of the same diameter as those of the shell were the more numerous. The adventitious tubuli, however, were readily distinguishable from the others by the circumstance that they were spread out in a *horizontal* network, and consequently ran at right angles with the proper tubuli of the shell. Of sporangia I noticed only in one spot some indications on a rather wide canal, upon which were visible two rounded, opaque swellings; but I would not venture to assert that these bodies were really *sporangia*.

2. Amphistegina. (Fig. 5.)

Five sections of this genus contained fungi. They occurred principally in the marginal parts of the shells, and appeared as branched canals, about 0·002‴ or 0·003‴ in diameter. Besides these wider canals, others of less dimensions also occurred, which I think must be regarded as of the same nature, especially on account of their horizontal and often much lengthened course. No *sporangia* were observed in this case, whilst in certain spots in those parts of the shell which bounded the chambers very young individual fungi might be observed, under the form of short pyriform vesicles, whose narrow extremity was directed towards the cavity of the chamber.

3. Heterostegina

Contains fine-branched and, as it would appear, occasionally anastomosing fungus-filaments, running chiefly in a horizontal direction between the fine tubuli of the shell which they thus crossed. No sporangia.

4. Calcarina.

Three sections of this genus contained a few fungi, represented by sometimes fine and branched filaments, sometimes by wider, short, pyriform, and elongated tubules, aggregated in the most superficial layers of the shell, and which probably represented a younger condition of the other filaments. No indication of sporangia.

5. Orbitolites complanata. (Fig. 6.)

Ten vertical and horizontal sections of this genus all contained numerous fungi, generally speaking of the same two kinds as in *Amphistegina*. In general the wider canals were the more numerous, and these also presented frequent dilations, and were more serpentine than in the last-named genus. The parasites were in this case also situated more in the superficial layers of the shell, though some penetrated through its entire thickness. Numerous young fungi were seated in the walls of the chambers, in the layers immediately bounding them, in the form of pedunculated, roundish, and pyriform vesicles.

6. Polystomella.

Nine sections of shells of this form all contained numerous fungi of the same two kinds as those in *Amphistegina*. Young, undeveloped individuals might also be observed.

7. Alveolina Boscii

Contained numerous, far finer fungus-filaments, with some of greater size. Numerous young forms.

3. Anthozoa.

In the great division of the *Anthozoa*, the calcareous skeleton of the stony corals is very frequently pervaded by fungi, whilst in other divisions of the class I have not yet certainly met with any parasites. My researches have hitherto been extended only to the following genera and species:

(*a*) *Porites clavaria*

Contains numerous, moderately-branched, fine and coarser fungus-filaments, from 0·002‴ to 0·0025‴, or even 0·003‴, in diameter, and very often supporting sporangia. These occurred only in the thicker filaments, and appeared to be rarely or never only terminal, but some always lateral as well. So that one filament of this kind would often be seen supporting 4 to 6 or even 8 to 10 *sporangia* in tolerably close apposition. In a few instances the lateral sporangia were shortly pedunculate.

(*b*) *Astræa annularis* (fig. 8)

Presents the same form of fungus, also abundantly fur-

nished with sporangia. The calcareous skeleton, moreover, contained numerous elongated cavities, placed in rows, and forming elegant feather-like figures. These appeared to be typical of the species, since they were always present, and were too regularly disposed to allow of their being possibly referred to a *fungus*.

(*c*) *Oculina diffusa*.

Fungus-filaments fine, scarcely exceeding 0·001‴ in diameter, in places much branched, so as to constitute figures resembling a stag's horn. *Sporangia* indistinct, sometimes round, sometimes appearing to occupy long tracts on the filaments. A great many small cavities, of irregular disposition and form, existed, which are necessarily to be referred to the fungus-filaments, and must not be taken to represent sections of them.

(*d*) *Oculina*. Sp.

Fungus-filaments fine, some very minute, which latter were frequently undulating in their course. No sporangia. Numerous opaque, minute points were noticed, which, as in the preceding species, are also probably to be referred to the parasitic growths.

(*e*) *Millepora alcicornis*.

As in Porites, except that the filaments, and sporangia were less numerous.

(*f*) *Lobalia prolifera*.

Fungus-filaments very numerous, but extremely minute, so that in most of them the canal and double contour could not be distinguished.

Course straighter. Branches rarely seen; and the only traces of sporangia consisted in irregular protrusions at the extremities of the thicker filaments.

(*g*) *Alloporina mirabilis*.

Filaments still more minute, but numerous. More intimate condition unascertainable. No sporangia.

(*h*) *Mæandrina*.

Fungi sometimes rare, sometimes very abundant. Filaments thick, even of considerable dimensions up to 0·006, or even 0·008‴, branched. Sporangia apparently elongated, but in my sections nowhere quite perfect.

in dentine, they have some relation to the nutrition of the shells. In my work upon *cuticular formations* and pore-canals, I remarked with respect to this subject, that certain of the tubuli described by Carpenter very closely resembled the pore-canaliculi of cuticular structures, among which I placed the bivalve shells; but at the same time, I stated that the horizontally spread and anastomosing canals of other genera must be differently explained. Lastly, the latest author who has occupied himself expressly with this subject, Wedl, has described the tubuli in all bivalves as vegetable parasites, with which opinion I now entirely coincide.

The genera and species examined by me are the following:

(*a*) *Anomia ephippium.*

To Dr. Carpenter's description I have chiefly only this to add, that in most of the coarser fungus-filaments rounded sporangia, and, as it appears to me, principally terminal, are placed. To judge from two of Dr. Carpenter's preparations, the fungus-filaments in the most superficial layers of the shell constitute a close network, from which straighter and less branched filaments, of greater or less size, run in very oblique directions into the inner layers. The sporangia are situated principally in the neighbourhood of the mycelium-plexus above mentioned, and measure as much as 0·02‴ or more.

(*b*) *Cleidothærus chamoides*

Contains, throughout the entire thickness of the shell, numerous fungus-filaments, usually of no inconsiderable size (0·003‴ or even 0·005‴), which in certain layers are much branched, and in the outermost coloured lamina present elongated enlargements, which can scarcely be regarded as anything but sporangia.

(*c*) *Lima scabra.*

A horizontal section, procured from Dr. Carpenter, afforded no distinct evidence with respect to the distribution of the fungus. The filaments, having an average size of 0·001‴ and 0·002‴, ran for the most part horizontally, some much branched and, as it appeared, also anastomosing, some straighter and supporting terminal sporangia, and in certain spots enlargements probably of the same nature.

(*d*) *Arca Noæ.*

A section of this shell, procured in England, presented only

straight and tolerably regularly disposed *tubuli*, which agreed in all essential points with those of the shells above noticed, but exhibited neither branches nor sporangia, and consequently could not be so definitely referred to a fungus-mycelium. But if Wedl's observations are taken into account, it may be confidently stated that this is the only correct interpretation they admit of.

(*e*) *Thracia distorta*

Contained a good many fine fungus-filaments, with numerous ramifications. Close to many of the filaments were large, round, finely granular bodies, which are probably sporangia.

(*f*) *Astrea edulis.*

In a shell much excavated by *Clione*, the portions yet retaining their integrity were pervaded by a greater abundance of fungus-filaments than I have as yet observed elsewhere. The filaments were rather closely branched, and occasionally presented terminal enlargements, which could perhaps be regarded only as sporangia.

(*g*) *Meleagrina margaritifera.*

A beautiful vertical section of this shell was particularly interesting, from the circumstance of its showing that ***shells with a perfect prismatic layer might also contain parasites.*** These were most developed in the outermost layers of the prismatic stratum, but in many instances through its entire thickness, and beyond it to a greater or less depth into the nacreous layer. The filaments were some 0·002 and 0·003‴, some finer, and no sporangia were visible upon them.

Many other bivalve shells presented no trace of parasites. Among which may be enumerated—*Pinna ingens, Pinna nigrina, Mya arenaria, Unio occidens,* the prismatic layer of *Perna ephippium, Avicula, Crenatula, Malleus albus.*

5. Brachiopoda.

The shells of certain Terebratulæ, besides the well-known coarser tubes, are also penetrated by extremely minute canaliculi, which, in respect to appearance and diameter, closely resemble the tubuli of dentine, and can scarcely be regarded except as fungus-filaments.

They were seen in *Kraussia rubra, Terebratula Australis,* and *T. rubicunda,* for sections of which I am indebted to Dr.

Carpenter. The tubuli, which appear to commence on the exterior, are rare, usually run in a ventical direction through the fibres, but, nevertheless, present such irregularities in their course as, together with the circumstance that in some spots they are wholly wanting, seem to indicate that they do not belong to any typical structure.

In *Rhynchonella nigricans*, *Terebratula Caput Serpentis*, and *T. resupinata*, no vestige of these fine tubules was perceptible. On the other hand, in *Leptæna lepis*, from the transition-formation, Wedl has found vegetable parasites.

6. Gasteropoda.

The canals in these shells, which were first noticed by Claparède, have been referred by Wedl to a vegetable parasitic growth—an explanation whose correctness admits in part of easy proof, inasmuch as, in certain cases, distinct *sporangia* may be observed on the canals. I have examined the following shells:

(*a*) *Murex trunculus.*

In the outermost layers of the shell may be observed a horizontally spreading mycelium, constituted of anastomosing fungus-filaments, of whose delicacy it is difficult to form any idea, since the meshes of the plexus are in many places hardly double the diameter of the filaments.

Very numerous straighter filaments arising from this layer of mycelium passed inwards, penetrating all the laminæ of the shell either vertically or obliquely, and throwing off frequent branches. On arriving at the innermost lamina, and not unfrequently even before doing so, these filaments would again spread out in a horizontal plexus. No sporangia could be perceived. The fungus-filaments measured, for the most part, about 0·001‴, though some reached a diameter of 0·002‴.

[Other species of gasteropod shells examined by the author, and which presented appearances more or less similar to the above, are:]

Murex brandaris.	*Haliotes*, sp.
Vermetus, sp.	*Tritonium cretaceam.*
Turbo rugosus.	*Litorina litorea.*
Aphorrhais pes Pelecani.	*Terebra myurus.*

Whilst in species of *Oliva*, *Cypræa*, *Nautilus pompilius*, and *Aptychus*, he was unable to detect any growths of the fungus character.

7. Annelida.

The tubes of two undetermined *Serpulæ*, from the coast of Scotland, were pervaded most abundantly with fungus-filaments, in which, however, neither anastomoses nor sporangia could be perceived.

8. Cirrhipedia.

In this division I have found structures which could with certainty be described as fungus-filaments, only in a large *Balanus*. They occurred both in living and dead shells, were extremely abundant, usually branched, and occasionally connected at the extremity with elongated, curved, widish spaces, probably sporangia. In one instance the filaments formed beautiful anastomoses. Besides these fungus-filaments, it would appear, at any rate from Quekett's description ('Histol. Catal.,' i, pp. 263—265, Pl. XVII, fig. 12), that other tubuli occur in the shells of *Balani*, which are probably of a typical nature, although from the representations of that author it is not clear whether, among the structures described by him, there might not be some corresponding with those I have noticed above. Moreover in *Pollicipes*, as is also remarked by Quekett, tubuli exist which, from their regular course in distant rows, in all respects resemble a typical structure. In the opercular pieces of Tubicinella, also, I have found tubuli which, from their being unbranched and running parallel to each other, resembled a normal structure. They were placed, however, far closer together than the tubules in *Pollicipes*, and I am compelled, for the present, to suspend my judgment respecting them. The statement made by me in another place ('Wurtzb. Verh.,' Bd. x), that fungi occur also in *Diadema*, I must retract as erroneous. The mistake arose from the wrong ticketing of the preparation of a gasteropod shell.

9. Fish.

As stated above, the observation of parasites in the scales of *Beryx ornatus*, from the Chalk, was the starting point of the investigation here recorded. The parasites of these scales are by far the most elegant of any hitherto met with (fig. 9), and correspond essentially with those figured by Mr. Rose. They are unicellular organisms, constituting stars with 8, 16, or 32 rays, at the extremities of which the sporangia appear to be developed, inasmuch as in large individuals the rays are not unfrequently slightly clavate. Although usually there are

not more than thirty-two rays, cases nevertheless occur in which the growth appears to advance still further, although I have not yet succeeded in obtaining good views of such individuals. This form of *fungus* might, as I am informed by my colleague, Professor Schenk, constitute a new genus; but I willingly leave this to the botanists.

In the scales of living Ganoid fishes, in many of those from fossil genera belonging to this division, which have been placed at my disposal by Professor Williamson, as well as in the scales of Teleostei, I have up to the present time in vain sought for fungus-filaments, although it would seem, at any-rate from Mr. Rose's researches, that they do prevail to a certain extent in these organs also.

This is the extent of my present researches. Taken together with those of Wedl, which have also been extended over a certain number of fossil molluscous shells, they serve to show that in any case the occurrence of vegetable parasites in the hard structures of animals is very frequent, and that this phenomenon must henceforth take its place among the certain acquisitions of science. Nevertheless, with respect to particulars, much remains to be ascertained, and I would direct attention principally to the following points.

1. *The parasitic growths are very frequent in marine animals, whilst they are almost wholly wanting in those belonging to fresh water.* In the latter, they have been noticed only in *Cyclas* (Carpenter), *Neritina fluviatilis* (Claparède), in the scales of an undetermined fish (Rose), and in *Neritina croatica* and *Melania Hollandrii* (Wedl); whilst in five fresh-water bivalves and eight gasteropods examined by Wedl, these growths were absent. The reason of this is not clear. It is either to be sought in the circumstance that the appropriate lower plants occur only sparingly in fresh water, or that such a difference exists in the conditions of vegetation of the two kinds of plants, that those belonging to fresh water are incapable of disintegrating the hard parts in question. But this is an inquiry whose answer may properly be left to the botanist.

2. *Among marine animals also, the parasites are not found indiscriminately in all.* In the mollusca they are indeed so abundant that it would almost appear that it is only by chance that they are absent. Nevertheless it seems, as has already been noticed by Wedl, that a thick *periostracum* and the prismatic layer present difficulties to the penetration of the mycelium which, in many cases, it cannot get over. Moreover, the parasites are absent in chitinous structures almost without exception, especially in those that are less calcified (Decapods). In the strongly calcified forms also,

they appear to occur only in cases where an external uncalcified layer is not present, as in *Balanus* and *Serpula*; whilst in the opposite case they are absent. In corals and foraminifera again parasitic growths are very general, whilst in the Spongiadæ they are often wanting.

3. The *penetration* of the parasites appears to take place in two ways—a mechanical and a chemical. The latter is doubtless the case in all calcareous skeletons, in which scarcely any other supposition can be entertained except that the parasitic growth, as it advances, dissolves the carbonate of lime contained in the tissue, by the secretion of an acid. Whether this be carbonic acid, or one of an organic nature, must be determined by future inquiry. All that can now be remarked is, that the supposition of the agent being carbonic acid is hardly supported by the fact stated by Bischoff ('Lehrb. der Chemischen Geologie,' ii, p. 1136), that oyster shells are far more difficultly soluble in water containing carbonic acid than are chalk or powdered calcspar; and which is in accordance with the preservation of shells and the other hard tissues in question in sea-water which contains carbonic acid. Were it the case that the hard structures concerned contained more organic material than at any rate the bivalve shells and stony-corals actually possess, it might also be supposed that the fungi first attacked the organic substance (which, it is true, is very doubtful), and then removed the carbonate of lime by the secretion of carbonic acid. However this may be, it appears that in any case the solution of the calcareous matter takes place only at the terminal, growing end, since the fungus-filaments are never lodged in wide vacuities, but, on the contrary, throughout their course are closely surrounded by the hard tissue. It is also to be remembered, that it is difficult to perceive what becomes of the dissolved carbonate of lime. It cannot well remain in the fungus-filaments; whilst, on the other hand, when their often very considerable length is considered, it is difficult to suppose that it is conveyed through them and deposited on the exterior; and yet any other supposition seems scarcely possible, and the more especially as the probable existence of a continuous reciprocal action between the water and the filaments at the surface of the shell should not be lost sight of.

In the case of the sponges, a mechanical penetration of the fungi may be supposed to take place, since it is impossible to conceive in what way they can be enabled to dissolve such a resistant substance as the horny skeleton of these creatures. An analogous mechanical penetration is witnessed in the passage of parasites through cellulose-mem-

branes, and would require merely a certain displacement of the molecules of the tissue, which certainly takes place in moist sponge-fibres, as is obvious from their powerfully absorbent property.

4. With respect to the *nature of the parasites*, Wedl and I are so far not in accord, that he describes them as *multicellular* plants, and, indeed, as *algæ*, whilst I regard them as unicellular *fungi*. With respect to the uni- or multicellular nature of the growths, I think my view is supported by the circumstance, that on the close survey of numerous, and more particularly of the wider canals, no trace of a partition-wall has anywhere been perceptible. Whilst, as to the question of their being Algæ or Fungi, it is not for me to give a reply, inasmuch as it is well known that botanists do not find it easy to draw good lines of distinction between the two divisions, and that the first botanical authorities entertain opposite views with respect to certain divisions. (*Vide* Nägeli, 'Gattung. einzell. Algen,' Zürich, 1849, pp. 1, 2; and Verhandl. d. Deutsch. Naturf. in Bonn; Cohn, 'Entwicklung der niedern Algen und Pilze,' Berlin, 1850, p. 139 *et seq.*; and Pringsheim in Jahr., f. wiss. Botan. 1, 2, p. 284 *et seq.*) It cannot be denied that the beautiful networks observed in many situations, and analogous to those of the mycelium of fungi, and the mode of fructification, appear to indicate the fungoid nature of the parasitic growths; and I shall, therefore, for the present, describe them as such. The naming of them I willingly leave to those who are alone entitled to undertake it.

NOTE *to the above*. By Dr. J. S. BOWERBANK, F.R.S., &c.

I CANNOT concur with Professor Kölliker in the belief he entertains that the tubular fibrous tissue surrounding the skeleton fibres of the pieces of sponge I gave him are originated by vegetable parasites.

The Sporangia, figure 3 in his paper, and other similar forms, are of common occurrence on sponge fibres, where no such network of tubular fibre occurs, the saline matters remaining in sponges always attracting so much moisture, as to cause them to be abundantly infested with parasitic forms of vegetation; but, notwithstanding these favorable circumstances, I have never met with this curious network but in three species of recent ceratose sponges, although I have examined many hundred specimens of them. Another fact in favour of their being really organic tissues of the sponges is, that very similar canals occur in siliceous sponge

spicula in my possession, and in these cases we cannot reasonably attribute them to the action of parasitic forms of vegetation.

When these minute tubuli are completely separated from their matrix, they still preserve all the characteristic appearance of ceratode, and their thickened glue-like aspect is very dissimilar to the delicate translucent forms of minute vegetable tissues.

The young and immature fibre of the true sponge, much less in diameter than the adult fibre, are usually destitute of the network of tubular structure that surrounds the others; but this we can scarcely imagine would be the case, if it were due to a parasitic vegetation. The adult fibres are also often partially destitute of the tubular fibre, in consequence of its having been stripped of the sheath that surrounds it, on the inner surface of which these minute tubular fibres are embedded. The stripped fibres of the skeleton may easily be recognised by the faint diagonal lines upon them, which are not visible through the external coat of the vegetable fibre.

Similar tissues to those in sponges which I gave to the author occur also in siliceous fossil sponges. These I have figured and described in the 'Annals and Magazine of Natural History,' vol. x, pp. 18 and 84, Plate III, figs. 2 and 6, from green jaspars from India, and 3 and 4 from chalk flints. An identity of organization may naturally be expected to occur between the recent and fossil sponges; but it is difficult to conceive these tubes to be effected by parasites under such widely different circumstances of time and place as those of the fossil and recent specimens.

ATMOSPHERIC MICROGRAPHY. *On the* MEANS *by which all the* CORPUSCLES NORMALLY INVISIBLE, *contained in a* DETERMINATE VOLUME *of* AIR, *may be collected into an infinitely* SMALL SPACE. By M. POUCHET.

('Comptes rendus,' April, 1860, p. 748.)

I HAVE succeeded, by means of a very simple instrument, in concentrating, upon an infinitely minute surface, all the solid and normally invisible corpuscles floating in the atmosphere, so as to allow of their being strictly appreciated and counted. By this means we can, if we please, concentrate on

a glass, and within a space of two square millimètres, all the particles disseminated in a cubic mètre of the atmosphere, or even more.

By this new method we have proved once more a fact which we had previously advanced. We have been enabled to see that the spores of plants and the ova of Infusoria, as has been equally recognised by MM. Joly and Ch. Musset, were infinitely rare, even in situations where they might have been expected to occur. Thus, in our laboratory, where almost throughout the year microzoa and mucedinous fungi are continually pullulating, I have been unable, in 1000 cubic décimètres of the air of which I have concentrated the invisible corpuscles by the aid of my instrument, to find a single infusorial ovum, nor a single spore.

The volume of air, however, just stated is erroneous, when compared with the small quantity necessary to produce an abundance of proto-organisms. In fact, whenever a suitable infusion is employed, and placed in contact with not more than a cubic décimètre of air, that is to say, with the thousandth part of the volume explored, millions of Infusoria or of Cryptogamia are almost always sure to make their appearance in it.

The instrument which we employ to concentrate the atmospheric corpuscles is constructed as follows. It is formed of a glass tube, closed hermetically at each end by copper stop-cocks. The upper stop-cock, which is fixed, receives a copper tube, terminated exteriorly by a very small funnel, whilst internally it is drawn out into a very fine point, the opening of which does not exceed 0·50 mm. in diameter. By the lower stop-cock a flat, circular disc of glass is introduced into the apparatus, which is placed at the distance of one millimètre from the elongated point of the tube. The apparatus is then closed, and the interior is placed in communication with an aspirator, by means of a tube which traverses the lower stop-cock.

When the aspirator is put into action, the surrounding air being sucked in, passes through the tube, and issuing from its pointed extremity, strikes upon the glass disc, and deposes on its surface all the atmospheric corpuscles contained in it, precisely in the same way that in Marsh's apparatus the metallic particles, issuing from it, are deposited on the plate of porcelain. The more bulky particles all collect into a small, central heap, which, however, does not exceed a millimètre in diameter; whilst the others only radiate at a little greater distance around it.

When the glass which has thus received the jet of air is

extracted with care and examined under the microscope, there will be found concentrated upon it, and on a surface of extreme minuteness, all the corpuscles which float invisibly in a volume of the atmosphere relatively immense, and which can be accurately determined by calculation from the known capacity of the aspirator.

In order to give the apparatus still greater precision, and to preclude the possible escape of any corpuscles, even among the most minute and lightest, the glass disc may be covered with some adhesive substance. By this means every particle, without exception, will be attached to the surface at the very spot to which the current of air conveys it.

If it be preferred, the corpuscles may be disseminated upon the glass disc, if the tube be terminated not by a single minute orifice, but by a small flat diaphragm, perforated like the rose of a watering-pot.

On the other hand, whilst my *aeroscope*, as it may be termed, clearly demonstrates that that abundance of germs of which so much talk is made, but which has never been shown, nowhere exists in the air: by a series of comparative experiments in sowing the atmospheric corpuscles, under circumstances favorable to the development of the proto-organisms, I have never seen that the soil thus sowed was more fecund than that which had not.

Nevertheless, if we were able, as is pretended, to sow cryptogams or microzoa collected from the air by means of balls of cotton, it is evident that every time these atmospheric corpuscles were placed in suitable circumstances, a quantity of proto-organisms would also be developed proportionate to the amount of atmospheric detritus employed. But, I repeat, experience has refuted all such pretensions.

In similar vessels, under glass-bells of the same capacity, at identically the same temperatures and degrees of pressure, and in equal quantity, flour-paste, sowed with atmospheric corpuscles, has never shown itself more fecund in organisms than that which had not undergone this preparation. This sowing was very readily effected, either by the aid of a fine muslin tamis, to disseminate the spores, if there had been any; or simply by the exposing of the vessels in situations where the air had been agitated, in order to secure an abundant deposit of its corpuscles. Vessels thus sowed, and those carefully covered over, were equally fertile. Further than this, some Nile mud, heated for an hour to 160° C., and reduced to powder, was not less prolific than that which had not been submitted to that temperature. Nevertheless, according to the opinion opposed to us, the contrary of what we observed should have taken place. We have, moreover,

sowed many other bodies, and have found, in all these cases, that the atmospheric dust was never more productive than they, and often even not so much so.

It seems to me, I would say in conclusion, that whenever an experimenter asserts that he collects in the atmosphere *ova* or *spores* of proto-organisms, he should be required to show them. Several of these germs, in fact, are perfectly well known. Such, especially, as divers spores of Mucedineæ, in which certain modes of illumination discover microscopic characters altogether peculiar; and the same with the ova of several Polygastricæ.

[The author proposes to employ his instrument for the microscopic analysis of the air of hospitals and marshes, &c., and promises to communicate the results on a future occasion.]

REVIEWS.

A Manual of the Sub-kingdom Protozoa. By Joseph Reay Greene, B.A. London: Longmans.

We learn from the preface to this little volume, that it "is the first of a series of similar treatises on the several departments of the animal kingdom;" and from the cover of the book we find that it is intended to herald a series of scientific manuals. A manual of systematic botany is in preparation by the distinguished professor of botany in the University of Dublin. Professor Greene's work is a capital commencement of the series. In beginning with the Protozoa, the author had a subject of some difficulty with which to commence, but just such a one as an ardent and industrious student would be glad to deal.

Mr. Greene does not stop to theorise, but, after a short introduction on the general principles of zoology, he at once proceeds to define the group Protozoa, which he makes to include the following families:—

1. *Rhizopoda,*
2. *Polycystina,*
3. *Spongiadæ,*
4. *Thalassicollidæ,*
5. *Gregarinidæ,*
6. *Infusoria.*

All these groups are of especial interest to the microscopist, and constitute, in fact, the great zoological field in which he is called to labour. We cannot follow Professor Greene through these groups to give his views of their constitution, but we can cordially recommend the volume, as giving by far the most advanced account that we know of amongst manuals devoted to zoology. Although the author shows that he is quite conversant with the recent literature of Protozoa, the work bears indications of original investigation in many of the forms of animals to which it is devoted.

The Nature-printed British Sea-weeds, a History, accompanied by figures and dissections, of the Algæ of the British Isles. By W. G. JOHNSTONE and ALEXANDER CROALL. Nature-printed by HENRY BRADBURY. Vol. II, Rhodospermeæ, Fam. x—xiii. Vol. III, Melanospermeæ. Vol. IV, Chlorospermeæ. London: Bradbury and Evans.

IN the first number of our present volume we noticed the first volume of this beautiful work, and it is a matter of surprise that we should be called upon to notice not only a second, but a third volume, before the close of the year. Such good speed is both creditable to publisher and authors, for the work that has been done must not be measured by the size of the volumes, but the care that has been bestowed both on the letter-press and illustrations. The second volume brings us to the end of the Rhodosperms, and is equally successful with the first in giving the correct forms of these charming sea-weeds. The third volume is devoted to the Melanosperms, and here the nature-printer has had more than ordinary difficulties to contend with, the thick and leathery forms of bladder wracks, with the gigantic fronds of Laminaria, seemed as if they would defy any attempt to induce them to produce a presentable picture of themselves. But by selecting young and delicate specimens, even *Fucus nodosus* and *Laminaria digitata* are made fit companions for those who trust to artistic skill for a place on the drawing-room table. As in the former volume, each nature-print is accompanied by drawings of microscopic structure, which will be found of great value to those who pursue their sea-side studies by the aid of the microscope.

The second volume is dedicated to Dr. R. K. Greville, of Edinburgh, whose classical work on the 'Cryptogamic Flora of Scotland' is known wherever the science of botany is pursued; and the third is appropriately inscribed to Dr. W. H. Harvey, of Dublin, to whom all writers on the family of Algæ are so greatly indebted. Whilst going to press we have received the fourth volume of this beautiful work, which now forms the most complete monograph we possess of the Algæ of Great Britain. The last volume contains a synopsis, an index, an introduction, and a bibliography.

MEMOIR *on the* SPERMOGONES *and* PYCNIDES *of* FILAMENTOUS, FRUTICULOSE, *and* FOLIACEOUS LICHENS. By W. LAUDER LINDSAY, M.D., F.L.S.

THIS very able and laborious memoir was published in the 'Transactions' of the Royal Society of Edinburgh, and we call the attention of our readers to it, as affording by far the most exhaustive account yet published of the minute structure of the lichens. Dr. Lindsay, in his papers in this Journal, on the genus *Abrothallus*, and on the structure of *Lecidea lugubris* (vol. v), commenced that line of investigation, which he has carried out in this memoir to a large section of the whole family of lichens. In his introduction, the author draws attention to some of the difficulties which impede the progress of the inquirer in the path he has chosen for investigation.

"Spermogonological investigations are surrounded by many and serious difficulties; and it is, perhaps, but justice to those botanists who have hitherto avoided the study of the reproductive organs of lichens here to state what some of these difficulties or obstacles are. Prior to the introduction of the microscope, bodies so minute as spermogones and spermatia could not possibly have been properly studied. But even at the present day, when microscopes abound, it is to be feared that few of our best lichenologists are well versed in histology and the use of the microscope. It can scarcely be denied, further, that many botanists have been too much mere classificators or name-givers; they have devoted attention too exclusively to the discrimination of species and varieties, to the neglect of minute anatomy and physiology, as studied by the aid of microscopy and chemistry. Continental botanists are infinitely before us in the latter respect; we can show little or nothing in botanical microscopy comparable with the productions of the French school of observers, as published in the 'Annales des Sciences Naturelles,' or to those of the German school, as given in the 'Botanische Zeitung.' But the possession of a good microscope, facility in microscopical manipulation, and a familiarity with the general principles or facts of physiological botany, are not the only requisites or qualifications for investigations in spermogonology. The observer must be possessed of unwearied patience and perseverance; he must expect to meet, and he must bring to his task a determination to surmount and conquer, endless difficulties and disappointments. I have now examined carefully,

under the microscope, as I have already stated, many thousand specimens of lichens from every part of the known world, and, *in a large proportion of cases, with negative or unsatisfactory results.* I have frequently examined most anxiously several hundred specimens of a particular genus or species—for instance, *Peltigera* and *Siphula*—without once having the good fortune to meet with its spermogones or pycnides. But, on the other hand, in the midst of disappointments of this nature, I have been rewarded occasionally by the discovery of spermogones or pycnides hitherto unobserved and undescribed. It were desirable, further, that the observer should possess an almost unlimited leisure. The time consumed in manipulations so delicate—researches so intricate—is incredibly great. Koerber candidly speaks of leaving such investigations to those "die bei grösserer Musse solche subtile Studien verfolgen können."* It frequently happens that even a small portion of tree-bark or rock contains several lichens belonging to the families of the *Graphideæ, Verrucariæ,* and *Lecideæ.* Intermixed with the apothecia of these lichens, and with each other, may be a variety of spermogones and pycnides. The spermogones and pycnides may closely resemble each other in external character, or they may differ considerably. In either case it is often most difficult, if not impossible, at the present stage of our knowledge on the subject, to determine to what species of lichen each kind of spermogone or pycnide is to be referred. This is more especially the case when the organs in question are very minute, black, and cone-like, as in the old genus—erroneously so constituted—*Pyrenothea,* which is now found to consist almost entirely of the spermogones of other lichens. Such spermogones and pycnides are frequently indistinguishable from certain *Verrucariæ,* parasitic fungi, and even parasitic lichens; and the only means of deciding as to their real nature is by microscopical examination. Again, the spermogones of some lichens, as *Ricasolia herbacea* and *R. glomulifera,* and the pycnides of others, as *Peltigera,* so closely resemble in external appearance the nascent apothecia of the same species as to be indistinguishable therefrom without the aid of a microscope."

Dr. Lindsay defines the Spermogones as follows:

"1. *External Form.*—They are generally more or less oval or spherical bodies; sometimes wholly immersed in the substance of the thallus; more frequently partly immersed and partly projecting on the surface of the cortical layer; in some

* 'Systema Lichenum Germaniæ, von Dr. G. W. Koerber.' Breslau, 1855, p. 152.

cases, naked and sessile, seated on the surface of the horizontal thallus, or forming the terminations of the ramuscles in the erect fruticulose one. The immersed and semi-immersed spermogones are plunged in the substance of the medullary tissue of the thallus, and they are usually partly covered by the cortical layer, and partly encircled by the gonidic layer."

The other organs to which he more especially calls attention in this memoir are the Pycnides. These are described as follows:

"The Pycnides of lichens may be described generally as externally resembling in form, colour, site, &c., the spermogones, from which they can be distinguished only by microscopical examination. The essential difference lies in the character of the contained corpuscles—the *stylospores*, though the sterigmata also differ from those of the spermogones to this extent, that they are almost always simple, shortish, and stoutish, generating the stylospores only at their apices. The pycnides consist, like the spermogones, of a —1. Capsule; 2. Nucleus, made up of sterigmata, with *stylospores* instead of *spermatia* however; 3. Cavity; and 4. Ostiole. They resemble outwardly, and are frequently mistaken for—*a*. Spermogones; *b*. Minute *Verrucarias*; *c*. Parasitic Fungi; and *d*. Parasitic *Lecideæ*, such as those mentioned under the head of spermogones. From all of these bodies they can only be distinguished by careful microscopical examination.

"They resemble the organs known as *Phoma*, *Septoria*, *Diplodia*, &c., which, according to Tulasne, belong, as secondary reproductive organs, to various thecasporous fungi. Their occurrence, alike in fungi and lichens, is a strong link binding together in close alliance these two great cryptogamic families. They are more plentiful in the lower than in the higher,—in crustaceous than foliaceous, lichens,—or, in other words, in those species most nearly approaching, in other particulars of their organization, the fungi. In crustaceous species they usually occur as very minute, black perithecia, resembling the apothecia of *Verrucaria*. But in the higher lichens, they are frequently much larger, more closely resemble the spermogones, and are variously coloured, as in *Peltigera* and *Alectoria*. In the first-named genus they are marginal, like the apothecia; in the other, they are seated sometimes as warts on the thalline filaments, or in the axils of their ramifications.

"Pycnides are sometimes associated both with spermogones and apothecia; sometimes with apothecia alone, no spermogones being present. Occasionally, pycnides and spermogones occur without apothecia, as in some species of *Strigula*; and

sometimes pycnidiferous states of lichens are found just as spermogoniferous states are — without either of the other forms of reproductive organs.

"The distinction between pycnides and spermogones is, to a certain extent, one of convenience—one depending on the difference in character of the contained corpuscles—not one as yet founded on essential differences in function, inasmuch as the function of neither can yet be said to be thoroughly established or understood. Hence it may hereafter appear that some organs now denominated pycnides should be really regarded as spermogones, as those of *Peltigera* and *Alectoria*, and perhaps, though less likely, the converse,—that some organs now regarded as spermogones should be looked upon as pycnides, as those of *Lichina*!"

The spermogones and pycnides of the crustaceous lichens will be treated of in a future memoir. In the mean time we are glad to find that Dr. Lindsay has undertaken to publish a 'Synopsis of British Lichens,' in which we understand the lichens will be nature-printed, and accompanied with drawings of their microscopic structure, by the author.

NOTES AND CORRESPONDENCE.

Another Object Finder.—As a subscriber to your Journal from its commencement, and having never before troubled you with a communication, I hope you will not refuse admission to one upon a subject that has repeatedly been brought before your readers already, but which, in my opinion, will still bear a little further consideration.

I allude to the article of "Object Finder." Almost every microscopist must be too well aware of the difficulty of quickly finding some particular scale, hair, desmid, diatom, &c., &c., with a very high power, say a twelfth or sixteenth, when the atom which we especially desire to examine is surrounded by hundreds of others, which, as we slowly roll them over the field by means of the traversing-plates, &c., confuse and weary the eye, until the operator's patience is completely exhausted.

The difficulty, of course, is greatly enhanced when, as is frequently the case, the embarrassed seeker is eager to exhibit the minute particle to friends who are anxiously awaiting his success. It is, therefore, no wonder that so much ingenuity has been exerted to devise various means to enable us to pounce *at once* upon the desired object, without that almost interminable bungling that I have described. But I believe they have all, more or less, been found unsatisfactory; some depending on unsightly circles, &c., scratched, or otherwise marked, on the object-slider itself; others consisting of various kinds of plates, finely graduated, the said graduations requiring to be found, focussed, adjusted, &c., and the said plate, moreover, being itself a separate piece of apparatus, to be looked for, and adapted to the instrument, whenever its use may be required.

Now, all this time, there has been in existence an apparatus that forms (or should form) part of every complete microscope; and which I verily believe to be the best "finder" that can be used.

I allude to the instrument called, in opticians' catalogues, a "double nose-piece."

In order to shorten the labour of finding an object with a

very high power, I have, for years, been in the habit of using a low power as a finder, and then bringing the object into the exact centre of the field (which is greatly facilitated by the use of that neat contrivance, the moveable pointer, without which no eye-piece is complete), change the powers by screwing off the low power, and screwing on a high one; then, on bringing down the high power to focus, if the achromatics are truly centred (which, of course, they will be, if the maker has done his duty), the desired object will still be found in the centre of the field. This mode of finding, as I can amply testify, is perfectly effective; but the heavy objection to it is the *figgle-niggling* (I like *expressive* words) process of screwing and unscrewing. Still I found it far better to do it than to waste time in the tedious hunting I have described.

Matters stood thus with me when I first heard of the aforesaid "nose-piece." Its construction was described to me, and it was recommended *merely* for what it is in the catalogues, viz., "a ready mode of changing one power for another, without the trouble of screwing and unscrewing." But I immediately saw further than that; "for," said I, "it is evident to me that, if properly made, it must *also* be the best 'finder' that can be used."

Accordingly, having procured one, I was greatly pleased to find my expectations amply borne out by fact; and exclaimed, "This is the very thing I have so long been wanting: EUREKA!"

And I am in hope that I am the first who has "found it out;" I mean, this particular application of it; for, as to the said nose-piece itself, it is really nothing new, being, in fact, merely a slight modification of the venerable old "six-lens wheel," with which what we now call the "ante-diluvian microscopes" were usually supplied. I have one still by me, purchased more than thirty years ago; and I have no doubt that, as the "march of improvement" advances, we shall, in due time, have the full complement of two-inch, one-inch, half, quarter, one-eighth, and one-sixteenth, mounted and acting exactly on the principle of a six-barrelled revolver.

But to come to the practical application of the matter in hand,—the power I recommend as a *finder* is one of those luxurious one and a half inch powers made by Mr. Ross, which exhibits a beautifully flat field, of great extent; and which I consider as low a power as we ever, practically, require.

On focusing with this, we shall, in many cases, see at one view all the objects on the slider; but, if not, a slight move-

ment of the traversing-plates, &c., will exhibit them. We have then merely to place the one we wish to subject to an enormous power at the end of the "pointer." Change the powers (which, by means of the nose-piece, is done literally in the twinkling of an eye), bring down the high power to focus, and instantly we see the tiny speck (which before seemed sticking on the point of the needle in the *centre* of the field), now swelled out so as to fill the *entire* field, and in many cases far beyond its limits; so that we must "traverse" it, and examine part at a time.

Oh, it is admirable! and the *velocity* with which it may be done must be *seen* to be *duly* appreciated. Let any doubtful amateur call on me, and bring his circle-finder, his angle-finder, or his graduated plate-finder, &c., &c., and I will undertake to convert him to the nose-piece finder in a very short time, and so perfectly, that he will not have the least desire to fall back upon any other.

Indeed, it would be a very amusing contest to see a meeting of several sharp-eyed and nimble-fingered microscopists trying their finders against time; each using, of course, the *same object*, and timed by the same observer from the second-hand pointer of a watch; the *watchman* saying, "Now," when the operator was to commence his search, and the searcher exclaiming, "Found!" the instant he had centred the object, and brought it to focus with the high power. In order, however, to give a *plate-man* some idea of the superior speed of the nose-piece finder, I will give a single example.

I took a slider of fossil animalcules, the part containing the objects exposing a circle of full seven tenths of an inch in diameter; the whole of that extent being crammed with *débris* of various kinds, among which is a very fine specimen of that beautiful object, the *Craspedodiscus elegans* of Ehrenberg. Placing this slider on the stage, and focusing it with a one-eighth, I began to "traverse" the circle; and I may truly say, with as much care as if anxious to exhibit the object to a waiting friend, whose time was "almost expired," &c.

After spending full five minutes in vain, I reversed the nose-piece, thus applying the inch and half; and I found that I could focus the objects, find out the desired one, move it to centre, reverse the nose-piece, and bring the one-eighth to focus, within ten seconds. In a subsequent trial I did the same in six seconds, or the time in which one can moderately count ten.

I do not believe that any one of the methods usually employed can be made to equal this.

But here an objector may say, "Well, but after all, this

nose-piece finder is not without objection; for it is "a separate piece of apparatus, to be looked for, and adapted to the instrument whenever its use may be required;" and, moreover, the screwing of it on and off will surely cause much more of what you are pleased to term "figgle-niggling," than the use of a graduated finder, &c. To this I answer, "No, such is *not* the case. There is no occasion, at any time, to remove the nose-piece, any more than to remove the stage or the reflector. I keep mine on at all times, with its finding-lens, the 1½inch, *firmly* screwed to it as a *permanent fixture*; any higher power being adapted to the *other* end of the revolving arm."

This is all I have to say upon a subject which, I fear, is very much like that of Columbus's egg; for I fully expect to be told, that "*any one* might have seen the applicability of the nose-piece as a finder," &c. No doubt of it; but the *question* is, *has* "any one" seen it? Meanwhile, I rest in hope that it is a new idea.

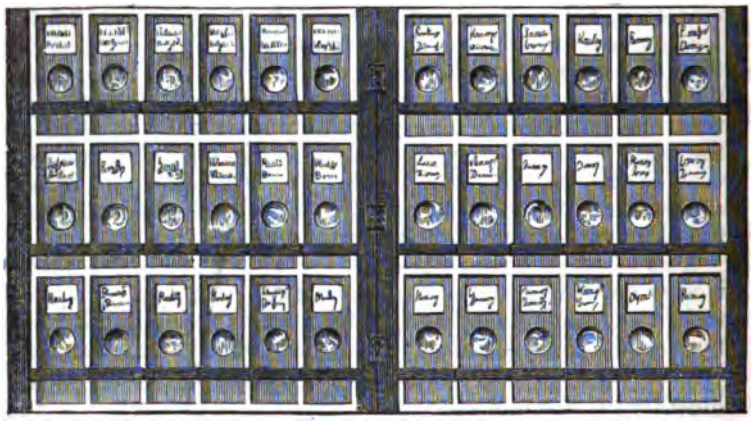
Before laying down the pen, I should like to take this opportunity of entreating microscopists in general to urge our opticians to direct their attention more to the Binocular Microscope than they have hitherto done. I am persuaded that it is capable of being brought far nearer perfection than it has yet been. For Nachet's instrument, though praised by a great authority, is sadly wanting in definition; and the *flaming* account of the American improvements (given in your Journal, No. V, p. 23), is I am informed, fearfully overdrawn! Our English makers say the difficulty is caused by the binocular principle reducing the angle, and thus causing indistinctness.

But may there not be some way discovered of getting over this? To those whose eyes are equally perfect, it is very annoying to have to *peep* with *one* only at a time, instead of using both at once, with as much ease and comfort as we use an ordinary pair of spectacles. It is also the cause of that injury to the sight of which so many microscopists complain.—HENRY U. JANSON, Pennsylvania Park, near Exeter.

The Object Cabinet.—I have endeavoured, in the accompanying drawings, to give some idea of a cabinet for microscopical preparations that I have now had in use for some time, and have found exceedingly convenient, from the great ease with which any particular slide may be found, and from other advantages which I shall briefly point out. It may be described as follows. Drawing No. 1 exhibits the cabinet opened out

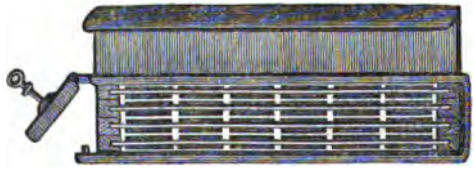
for use; and shows, in some measure, one of its principal

No. 1.



features, namely, facility of reference, which is further increased by the quickness with which the several leaves can be turned over. Drawing No. 2 is an end view of the same,

No. 2.



showing some of the details of its construction, and the manner in which the slides lie on both sides of each leaf. It consists, as represented in these drawings, of four pieces or leaves of thin wood, or other suitable material, having thicker slips fastened at either side, for the purpose of keeping the slides from touching one another when the cabinet is closed. Each leaf has also, as shown in the first drawing, three pieces of narrow elastic banding, fixed across it from side to side; and these are divided off into the requisite number of spaces by thread or silk passing through the boards, thus making a separate compartment for every object, which is kept firmly in its place by having the band somewhat stretched in putting on. The cabinet, which from its form may be properly called a "book cabinet," has two

light covers, and may either be fastened by an ordinary brass clasp, or by a lock, as in the drawing; at either end is a small leather or cloth flap to keep out the dust. The one figured as above will contain twelve dozen objects; but by putting eight slides in a row, and doubling the number of leaves, a single cabinet would hold 384 specimens: but both the size of it, and the number of objects it may be made to contain, is more a matter of individual convenience than otherwise; and where the quantity of any particular class of objects is sufficient, separate cabinets might be had for each, as for instance, Diatomaceæ and Desmidiaceæ insect preparations, &c., &c. Besides the ease of reference, which may be further facilitated by an index (each space being numbered), and by having particular classes of objects in separate books, as above proposed, the cabinet can be carried about from place to place, without in any way disturbing or moving the specimens; and this is sometimes an advantage, although but a trifling one.

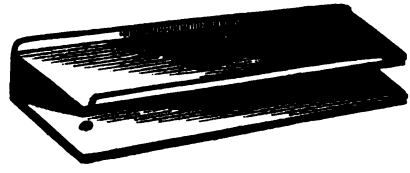
I have lately been given to understand that this form of cabinet is not altogether new, and that I cannot lay claim to having been the first to propose it; yet I have ventured to put forward the above drawings and description, from the circumstance of my own having met with so much approval from every one who has seen it, and as I am not aware that the plan has as yet been adopted or brought specially forward in any way.—JAMES SMITH, 21, Soley Terrace, Pentonville.

A new Polarising Stage.—The accompanying drawings show two different constructions of a selenite or polarising stage, which I have designed to obviate a slight difficulty in the examination of objects by polarised light, viz., that of having to alter the focal adjustment of the microscope every time the selenite is placed under the object to be examined, or removed from it; but by the use of either of the above forms of stage, the particular object to be examined having been once found and properly focused, it can be viewed, in the first place, by the polarising prisms alone, and afterwards with the selenite interposed, which can be exchanged for one or more of different tints, without in any way moving or disturbing the slide; and thus I conceive that, in instruments that are not otherwise specially adapted for the purpose, the various phenomena of polarised light (as applied to the microscope) may be more easily and satisfactorily observed.

Drawing No. 1 shows the simpler form of the stage (which,

from its construction, will be of very trifling cost). It consists of an upper plate with raised edges, for the purpose of

No. 1.



holding the object-slide, and an under plate on which to place the selenite, while to it are fixed two small pins, corresponding to two holes in the stage of the microscope, to attach it, when in use, to the instrument; the same object can, however, be effected by the ordinary clamping bar or spring, where the microscope has them, in which case the pins would not be required. In the second form, as shown in drawing No. 2, the selenite holder is fixed on to a small

No. 2.

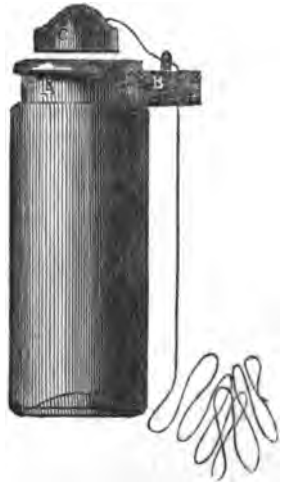
piece of tube, which turns round in another piece fastened to the bottom plate, and in this way the rotation of the film is effected. A very slight modification of this form will allow of two or three selenites being superposed where required. The selenite stage being fixed to that of the microscope, as before described, the necessary motions can be given by the proper screws, when the instrument has a rackwork stage; but where this is not the case, the horizontal motion must be given to the object itself, by sliding it along the top plate on which it rests.—JAMES SMITH.

The Collecting Bottle.—The accompanying drawings show the design of a collecting bottle for aquatic larvæ, infusoria, &c., which may possibly be found convenient by microscopists pursuing that line of study. It may be briefly described as follows:

Drawing No. 1 shows a wide-mouthed glass bottle, round the neck of which a strip of gutta percha is fixed, so as to

form a ring, A, while attached to it is a small socket of the same material, B, in which the rod or walking-stick is in-

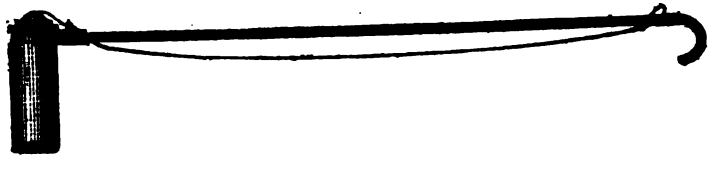
No. 1.



serted, as shown in drawing No. 2. A stopper or cork, also of gutta percha, C, formed so as to admit of its easy withdrawal when the bottle is in use, is fixed to the socket by a piece of string of adequate length.

The bottle, when used for collecting, is fitted to the rod or stick, as shown in drawing No. 2, and the stopper inserted in

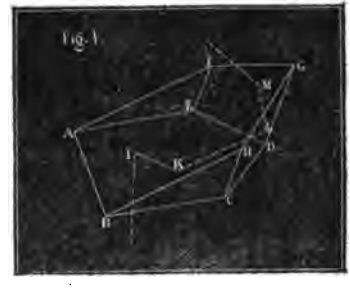
No. 2.



its mouth, while the string is held on a finger of the hand carrying the stick. The bottle may then be plunged in the water, in any position most convenient, and guided to the place from which the sample is required, when a slight pull at the string removes the stopper, allows the water to enter, carrying with it any small insects, &c., that may be near the

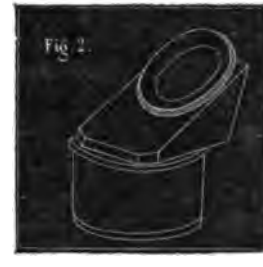
bottle at the time. It will be observed that the string is passed through a small ring at the top of the socket: this answers the double purpose of preventing the loss of the cork by its becoming detached from the bottle, and also of saving the bottle itself, should it by any chance become loosened from the stick while in the water; for in this case, as will be seen, it will still be held by the string and the cork to which it is fastened. I find, however, that practically there is no probability of this happening, as the gutta percha socket holds the end of the stick with a considerable degree of firmness, requiring some little force to detach it. The bottle can, of course, be used at any time without the cork, by simply drawing the string sufficiently tight to keep it out of the way. I have used gutta percha in the construction of the various parts, on account of the extreme facility with which it can be moulded into the required shape, and as any one can with it fit up a bottle in a short time, and at the cost of a few pence. But, doubtless, several other materials will suggest themselves, as convenience might place within reach; the socket, B, for instance, might be made of metal, with a screw corresponding to one at the end of the stick or rod, so as to allow of the substitution of a small net or a knife, for cutting off pieces of aquatic plants, &c. It might be found convenient by some to have the cork permanently fixed to the mouth of the bottle by means of a slight spring (which may be applied in various ways); it would thus be always ready for use, and the pulling of the string would only lift up or draw aside the cork, which, returning immediately to its place on slackening the string, might keep in some of the larger insects that would perhaps otherwise escape.—JAMES SMITH.

On an Erecting Prism.—The instrument represented in the annexed cut is intended to supply the place of the first erecting prism constructed by us, the use of which is attended with some inconveniences. Being placed above the upper lens, it obliges the eye to be held at some distance from the focus of the ocular; so that, in order to obtain a view of the entire field, it is necessary to alter one's position.



In the new instrument, the prism is placed between the

two lenses of the eye-piece. It is formed with two pentagonal faces, A, B, C, D, E, and A, B, H, G, F, joined at a common edge, A, B, and connected at the opposite end by two facets, C, D, G, H, and D, E, F, G. The solid formed by these surfaces represents pretty nearly a double wedge, of which the edges, A, B, and D, G, are perpendicular to each other. The way in which the erection of the image is effected may be readily conceived. The rays emerging from the field-glass enter by the lower surface, and are reflected at I upon the face A, B, H, G, F, from which they are again reflected upon the lower surface at the point K, and thence to the point L upon the vertical face C, D, G, H, and lastly at the point M upon the other vertical face, D, E, F, G, from which the image, normally and completely erected, is again sent back to issue by the superior surface upon which the eye-glass is placed. Consequently the two surfaces, looking towards the lenses of the eye-piece, are at the same time surfaces of reflexion and of transmission. All the reflexions are *total*, except the first at I. The upper surface is coated over the space between A, B, H, F, and left free between F, G, H, to allow the image to pass.



The loss of light is inconsiderable, owing to the energy of the convergent pencil put in action in this prism, which may be applied to magnifying powers far greater than those usually employed in the minutest dissections. The combination represents a weak ocular; so that when the eye-piece is approached to the objective, as small a magnifying power as may be wished is obtained.—NACHET.

On a Dark-Ground Illuminator.—I have found, that with the little instrument here represented, effects may be obtained as remarkable as those produced by the ingenious paraboloid of Mr. Wenham, which in its construction demands so much care, and is too large to be applied to certain instruments.

Our apparatus consists of a simple cone of glass, whose summit is directed towards the mirror, and base towards the object. This base forms a segment of a sphere, and the centre

is blackened so as to prevent the passage of all direct light to the object. The arrangement is the same as that employed by M. Amici for the illumination of objects with one of the colours of the spectrum, by making use of the solar light, and making the cone more pointed, and of flint-glass, in order to disperse the light sufficiently. In the cone here represented, which is made of crown-glass, the dispersion is not sufficiently great to give coloured rays, and the images consequently are perfectly colourless.—NACHET.

On an Oblique-Light Illuminator.—In cases where a very oblique light is required in order to see very delicate lines, the mirror and prism of Amici are often insufficient; or at any rate, they demand long and tedious adjustment, even with objectives which bring out with tolerable facility the most difficult tests. I have found that a very simple means of effecting this object consists in a slight modification of the old illuminator of Mr. Kingsley. The upper lens should be covered with a thin plate, having a perforation at the margin of the lens, so as to allow only a very sharp pencil to strike the object. I would remark that a notable difference exists between the diaphragm placed below the *éclairage*, as is generally done, and the arrangement now proposed, which has the advantage of cutting the luminous pencil after it has undergone all its evolutions in crossing the lenses. This combination has the focus sufficiently long to allow of its employment on preparations mounted on glass of the ordinary thickness.

With the objectives Nos. 7 and 8 ($\frac{1}{14}$th and $\frac{1}{18}$th inch), the lines on *Grammatophora subtilissima*, the undulating lines of *Surirella gemma*, and those of *Navicula affinis* (Amici's test), are immediately resolved with the aid of this arrangement of the illuminator. It moreover possesses the advantage of being readily applicable to instruments in which the stage is so thick that it is impossible to obtain an illumination sufficiently oblique for delicate researches.—NACHET.

Amphipleura pellucida.—In examining a series of fourteen slides of this diatom with an eighth objective, without any accessary apparatus, I have been enabled to come to a satisfactory conclusion that it is a sad misrepresentation to set down the lines so high in the scale as 130 in ·001″.

That the lines of some are exceedingly fine, and beyond my present means of giving a numerical limit, yet a few shells may be counted at 42, and many at 60, 70, and 80, in

·001; and I have but little doubt that *Amphipleura pellucida* may be found to take rank, in point of striation, as the alpha and omega of the lineated diatoms. Mr. T. G. Rylands, I believe in the 'Microscopical Journal,' for October, 1859, very correctly observes, "Having seen *Amp. pellucida* with transverse lines *much more distant* than the 130 to ·001" observed in that species by the Hull microscopists."

In the same Journal an article appears from Mr. Sollitt, who estimates the number at 130, along with several other microscopists; but no allusion is in any place made to the existence of any coarser striation.

It is hence evident, from the frequent occurrence of lower numbers, that even *Amphipleura pellucida* cannot be taken as any test of the quality of a high-power objective, since the striation may be seen, in some instances, with the $\frac{1}{6}$th, the $\frac{1}{5}$th, the $\frac{1}{4}$th; and, I think, a $\frac{1}{10}$th objective might even resolve some of the same; with a $\frac{1}{8}$th I can readily resolve some into squares of 60 or 70 in ·001".

My attention to the subject was first arrested through a beautiful slide presented to me by George Norman, Esq., of Hull, in which I accidentally found one Acus measuring 42 striæ in ·001", the length of which was ·0041". Having also a gathering of the same, I subsequently put up a few slides and found several others, one or two upon a slide of similar measure, with others somewhat finer, and quite sufficient to satisfy myself that a comparative coarse striation, compared to 130, was by no means an exception; and that, could all the gathering be fairly resolved, I know not how far might rather even constitute the rule, and the very fine, perhaps, the exception.

I am apprehensive that the 130 to ·001" is not legitimately arrived at; that to half and quarter is not a fair means; that vision and judgment are not matured upon this point, through want of proper objects of comparison; and that microscopists, generally, are not yet masters of the relative developments between Nobart's test-plate and the lined diatoms; as, for example, whether 60 lines on the diatom are seen in exact degree with 60 upon the test-plate, so as to decide the question of the term of visibility.—Wm. Hendry, Surgeon, Hull; June, 1860.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *April 11th*, 1860.

The ordinary meeting of the Society was not held, in consequence of the annual *soirée* having been fixed for this evening. The company assembled in the library and hall of King's College. About 700 persons were present on the occasion. There were about 150 microscopes exhibited, and many interesting objects displayed. The walls of the suite of rooms were covered with diagrams of microscopic objects lent by Mr. Busk, Dr. Carpenter, Mr. Mummery, Dr. Lankester, Dr. Wallich, and other members.

May 9th, 1860.

Dr. Lankester in the chair.

Col. Hennell, Rev. Edw. Crofton, and Henry Black, jun., Esq., were balloted for and duly elected members.

Several short communications were made, and discussions took place.

June 13th, 1860.

George Jackson, Esq., in the chair.

J. H. Dallmeyer, Esq.; J. B. Fletcher, Esq.; W. A. Harrison, Esq.; Geo. A. Ibbetson, Esq.; Geo. Boulton, Esq.; W. Vanner, Esq.; Jno. Hollingsworth, Esq.; Capt. W. D. Lowe; Rd. Stileman, Esq.; Albert Savory, Esq.; and Jas. Taylor, Esq., were balloted for and duly elected members.

The following papers were read:—"On an improved Binocular Microscope," by F. H. Wenham, Esq. ('Trans.,' p. 154), "On some New or imperfectly described Forms of Diatomaceæ," by Tuffen West, Esq. ('Trans.,' p. 147).

Presentations to the Microscopical Society since the 1st of January, 1860:

January 11*th.*

PRESENTATIONS.

	Presented by
Report of the Council of the Art Union of London for 1859	The Society.
Comber, On the Diatomaceæ of the Neighbourhood of Liverpool. Paper	The Author.
Four Slides of Diatoms	S. Andrews. Dr. W. Arnott.

February 8*th.*

Woodward's Manual of the Mollusca, and a Supplement	F. C. S. Roper.

March 14*th.*

Transactions of the Tyneside Naturalists' Field Club, Vol. IV, Part 2	The Society.
Quarterly Journal of Geological Society, Nos. 60, 61	Ditto.
Journal of the Proceedings of the Linnean Society, Vol. IV, No. 16	Ditto.
The Annals and Magazine of Natural History, Vol. V. No. 27	The Editors.
Recreative Science, Nos. 6, 7, and 8	Ditto.
The Photographic Journal, No. 94	The Editor.
Journal of Dental Science	Ditto.
Observations on the Distribution and Habits of the Pelagic and Fresh-water Floating Diatoms. Two Papers by Dr. G. C. Wallich	The Author.
A Monograph of the Fossil Polyzoa of the Crag. By G. Busk	Ditto.
Quekett's Practical Treatise on the Use of the Microscope. Second Edition	Purchased.
Histoire des conferves d'eau douce. Par Jean-Pierre Vaucher	Ditto.

May 19*th.*

Acta Academiæ Novorum Actorum Academiæ Cæsareæ Leopoldino Carolinæ Germanicæ nature curiosorum, Vol. XXVII	The Academiæ.
The Annals and Magazine of Natural History, Nos. 28 and 29	The Editors.
Catalogue "British Museum" List of British Diatoms	F. C. S. Roper, Esq.
Journal of Recreative Science, Nos. 9 and 10	The Editors.

	Presented by
Transactions of the Linnean Society, Vol. XXII, Part 4	The Society.
Proceedings of the Linnean Society. Supplement to Vol. IV, Botany	Ditto.
Photographic Journal, Nos. 95 and 96	The Editor.
M. P. Coulier, Manuel pratique de Microscopie	Purchased.
Gerber's Minute Anatomy, Text and Plates	Ditto.

June 13th.

Journal of the Proceedings of the Linnean Society, Vol. V, No. 17	The Society.
Photographic Journal, No. 97	The Editor.
Systema Algarum, par C. A. Agardh	F. C. S. Roper, Esq.

ZOOPHYTOLOGY.

Shetland Polyzoa. Collected by Mr. Barlee.

(Continued and concluded.)

Fam. Bicellariidæ, Bk.

Gen. 1. *Bicellaria*, Blainv.

1. *B. Alderi*, n. sp. Pl. XXVIII, figs. 1, 2, 3.

B. cellulis turbinatis, inferne valde attenuatis; aperturâ ovali, spinâ unicâ angulo externo positâ instructâ.

Cells turbinate, much attenuated downwards; aperture oval, a single marginal spine at the outer angle.

Hab. Shetland, *Barlee*.

B. Alderi, Bk. Rept. British Association, 1859. Trans. of Sect. p. 145.

Gen. Onchopora, Bk.

1. *Onchopora borealis*, n. sp. Pl. XXVIII, figs. 6, 7.

O. cellulis immersis, circa marginem perforatis; poro centrali elevato signatis; superficie subsulcato.

Cells immersed, punctured at the sides; a central raised pore on the front of the cell; surface faintly and irregularly sulcate.

Hab. Shetland, *Barlee*.

As only a very minute fragment of this species occurs in Mr. Barlee's collection, its fuller description must be reserved to a future occasion, and for more perfect specimens.

6. *Lepralia monodon*, n. sp. Pl. XXIX, figs. 3, 4.

L. cellulis, subpyriformibus, ovatis, seu ventricosis, superne liberæ, suberectæ; superficie punctata seu scrobiculata; orificio rotundo, peristomate incrassato, sæpius superne dentato.

Cells pear-shaped, ovate or subventricose below, free upwards, and raised; surface knitted; orifice round, peristome entire, thickened, often raised into a central blunt tooth at the summit.

Hab. Shetland, *Barlee;* on shell.

On further inspection of some of Mr. Barlee's specimens, I have met with the above form of Lepralia, which I am unable to reconcile with any hitherto described. From the single specimen in my possession, the nature of the tooth-like projection on the upper border of the mouth is not very

clear. In some instances it would appear to be perforated in front, as if for an avicularium, but in others it is smooth and entire.

SUB-ORD. CYCLOSTOMATA.

Fam. Idmoneidæ, Bk.

Gen. Pustulopora, Blainv.

1. *Pustulopora Orcadensis*, n. sp. Pl. XXIX, figs. 1, 2.

P. polyzoario irregulariter ramoso; cellulis numerosis, undequaque surgentibus.

Polyzoarium irregularly branched; cells numerous, arising irregularly on all sides.

Hab. Shetland, *Barlee.*

As this form is clearly neither *P. proboscidea* of Forbes, which, in fact, from the specimen so named in the British Museum, would seem to be not a Pustulopora at all, but a variety of *Cellepora ramulosa*, nor the *P. deflexa* of Mr. Couch, which appears to have a simple embranched polyzoary, I am induced to erect it into a distinct species. But since the species of this genus are as yet but little known, and very difficult to distinguish, except from numerous specimens, I am not sure it may not be identical with a *Pustulopora* which occurs in the Atlantic and in the Australian seas.

Plate XXVIII.

Fig. 7.

Fig. 6.

Fig. 4.

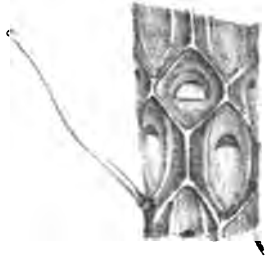


Fig. 5.

Fig. 1.

Fig. 3.

Fig. 2.

W. West, Imp

Plate XXIX.

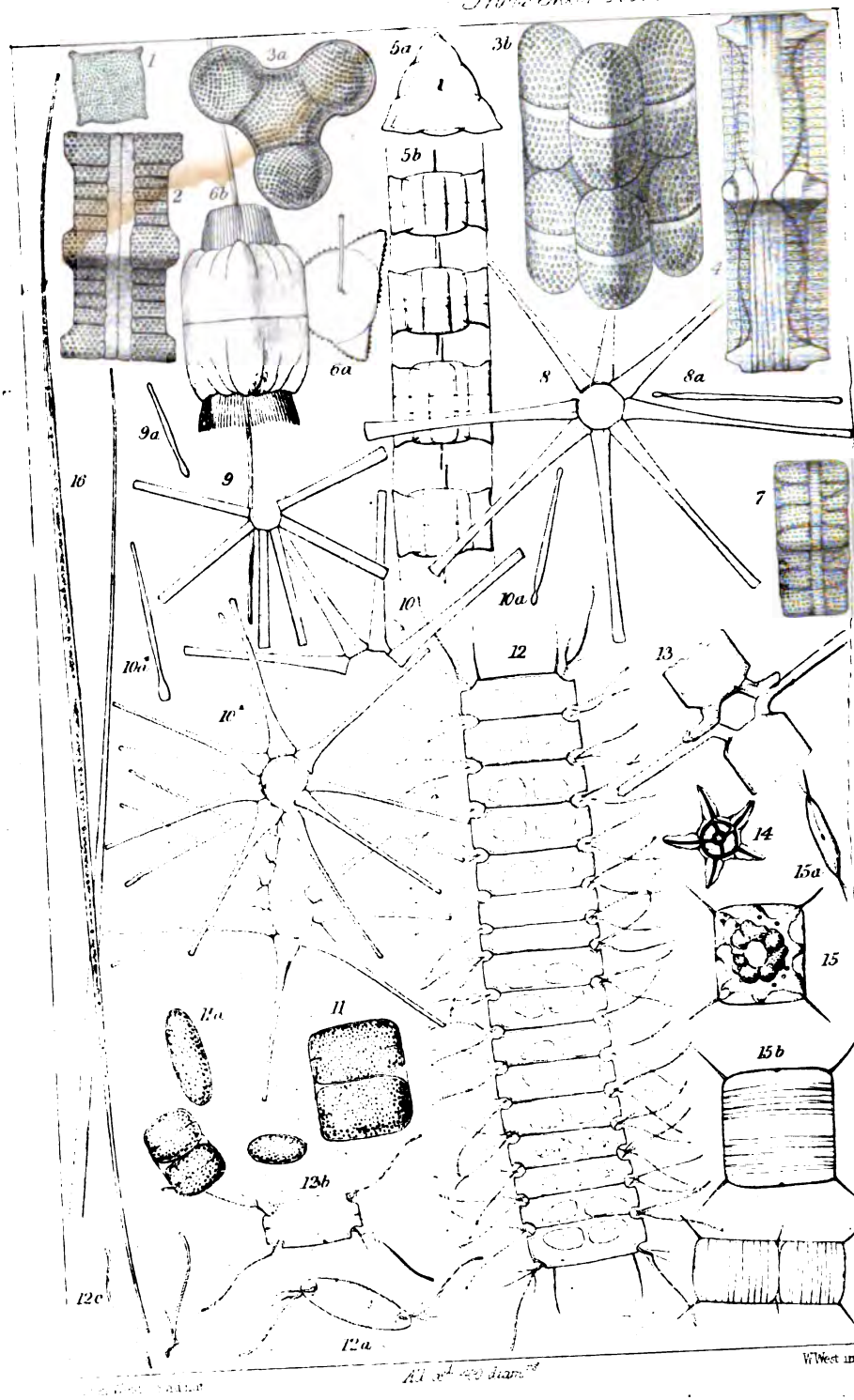
DESCRIPTION OF PLATES XXVIII & XXIX.

PLATE XXVIII.

Fig.
1.—*Bicellaria Alderi*, nat. size. (p. 213.)
2.—Anterior view of *B. Alderi*.
3.—Posterior view.
(These figures are taken from drawings by Mr. J. Alder.)
4.—*Salicornaria Johnsoni*, Bk., nat. size.
5.—*Avicularium* of *Sal. Johnsoni*.
(From drawing by Mr. Alder.)
6.—*Onchopora borealis*, nat. size. (p. 213.)
7.— „ „ × 25 diam.

PLATE XXIX.

Fig.
1.—*Pustulopora Orcadensis*, nat. size. (p. 214.)
2.— „ „ × 25 diam.
3.—*Lepralia monodon*, × 25 diam. (p. 213.)
4.— „ „ × 50 diam.



All ex^d 400 diam^rs

W. West imp.

DESCRIPTION OF PLATE VII,

Illustrating Mr. T. West's paper on New Diatomaceæ, &c.

Fig.

1.—*Triceratium parmula*, Br.; 4-sided variety.

2.— „ *venosum*, Br.; front view.

3.— „ *castellatum*, n. sp.; *a*, side view; *b*, front view.

4.— „ *radiatum*, Br.; front view.

5.— „ *intricatum*, T. W.; *a*, side view; *b*, front view of a filament; from drawings kindly furnished by Lieut.-Col. Baddeley.

6.— „ *Brightwellii*, T. W.; *a*, side view; *b*, front view (original figures).

7.— „ *variabile*, Br.; front view.

8.—*Asterionella formosa*, Hass.; filament of 8 frustules attached; *a*, side view.

9.— „ *Ralfsii*, W. Sm.; filament of 6 frustules; *a*, side view.

10.— „ *Bleakleyii*, W. Sm.; filament of 6 frustules; *a*, side view. From authentic specimens in the collection at the British Museum.

10.*— „ *Bleakleyii*, W. Sm., var.; (?) drawn from specimens obtained from *Noctiluca*, at Gorlestone; *a*,* side view.

11.—*Podosira* (?) *compressa*, n. sp.; filament of 2 frustules; *a*, side view.

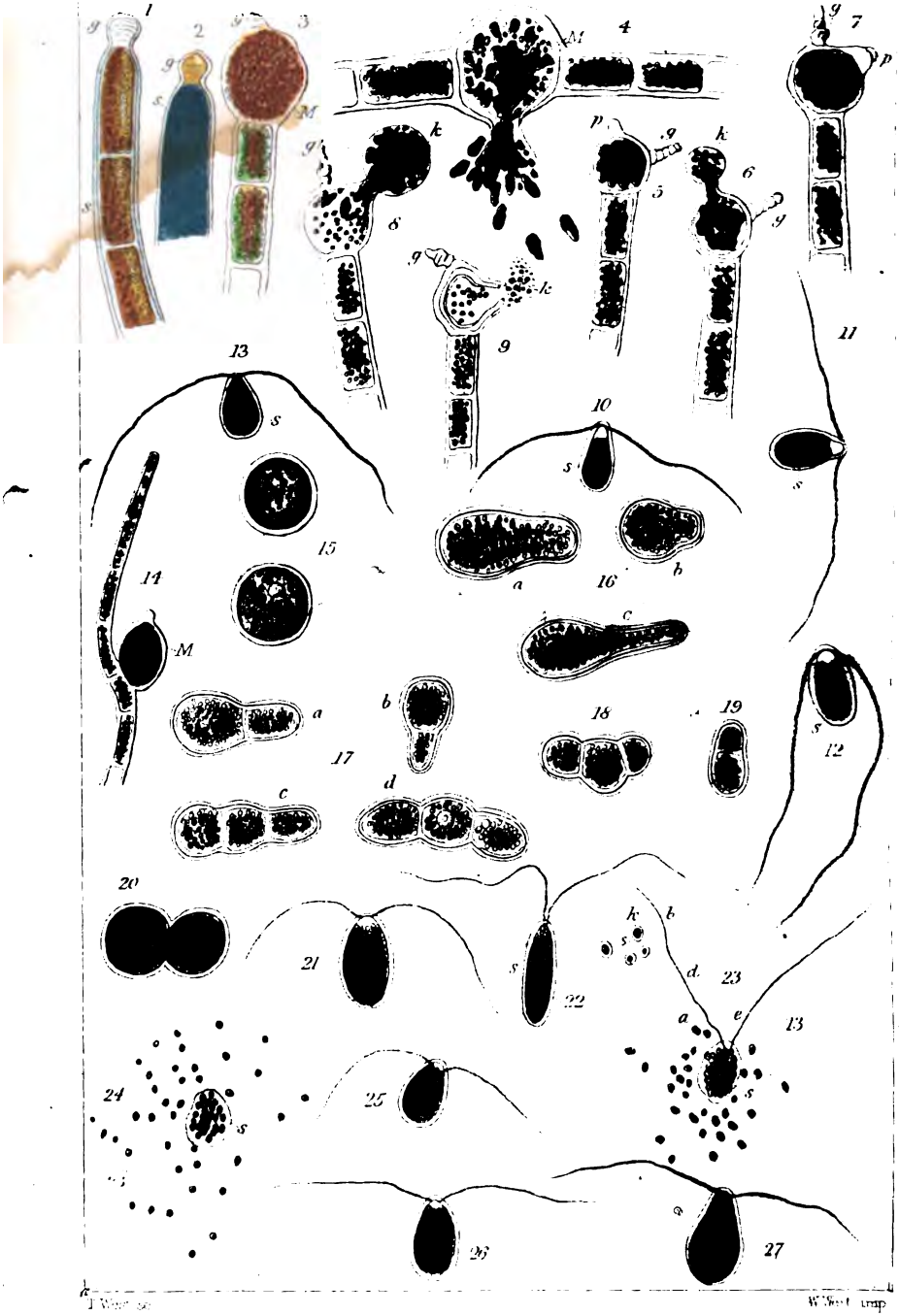
12.—*Chætoceros armatum*, n. sp.; filament; *a*, side view; *b*, front view of single frustule; *c*, one of the long curved horns with the delicate setæ still remaining attached, after action of weak nitric acid.

13.— „ *boreale*, Bail.; British specimen.

14.—*Actiniscus sirius*, Ehr.; British specimen.

15.—*Attheya decora*, n. sp.; frustule with endochrome; *a*, side view; *b*, frustules after burning.

16.—*Closterium aciculare*, n. sp.; *a*, frond with endochrome; *b*, empty segment.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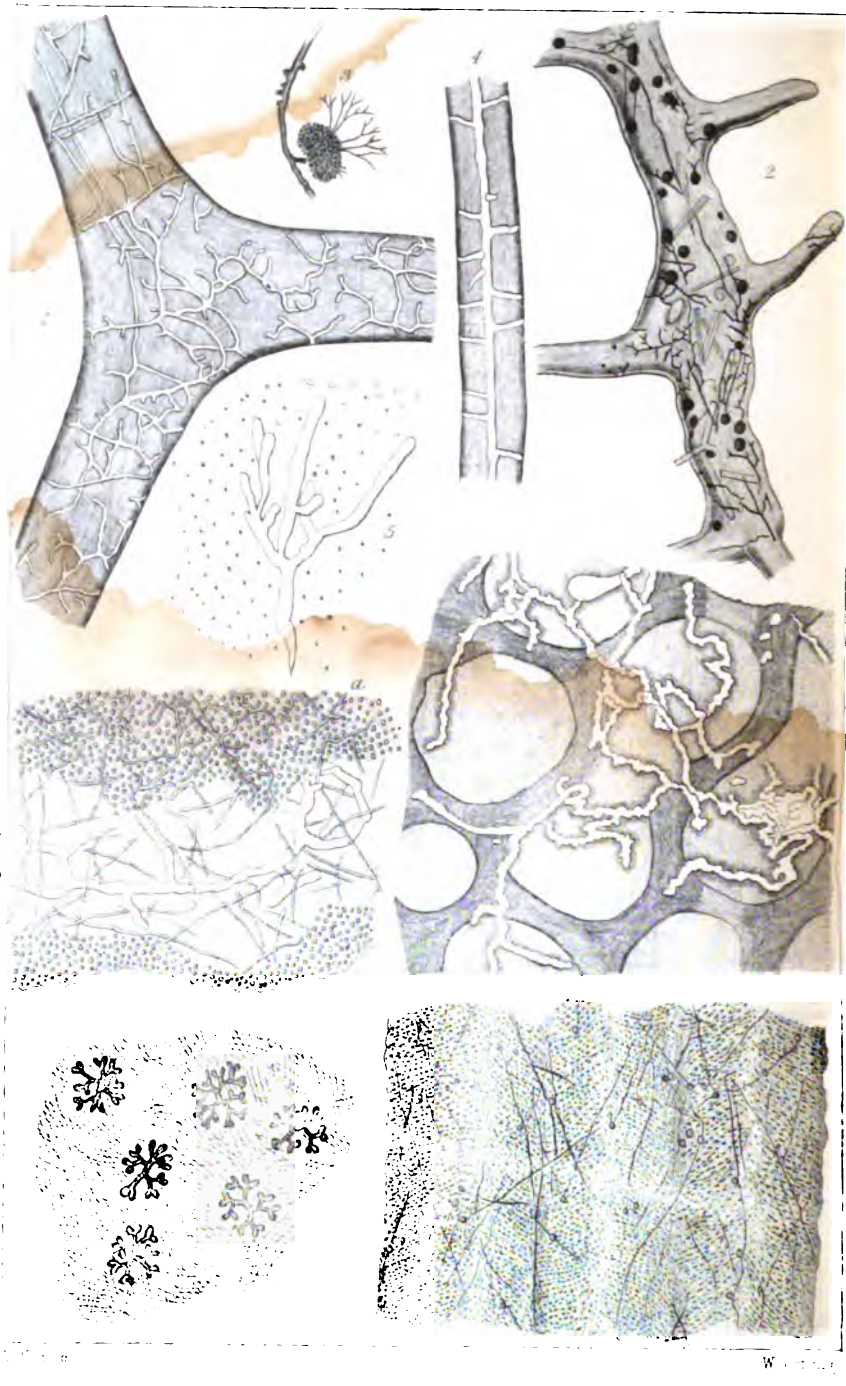
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DESCRIPTION OF PLATE VIII,

Illustrating Professor Kölliker's paper on the frequent occurrence of Vegetable Parasites in the Hard Tissues of the Lower Animals.

Fig.

1.—Portion of the horny skeleton of an Australian sponge, with fungoid filaments in the interior. × 250 diam.

2.—The same × 60 diam., with fungus-filaments, sporangia and spicula in the interior.

3.—Fungus-filament with sporangium, from which are springing young fungus-filaments; from the same sponge. × 360 diam.

4.—Horny fibre of a true sponge, with fungus-filaments opening on the surface. × 360 diam.

5.—Branched fungus-filaments from an *Amphistegina*, × 360 diam.

6.—Portion of the skeleton of *Orbitolites complanata*, with numerous fungus-filaments in the interior, × 360 diam.

7.—Portion of the shell of *Operculina*, with fine fungus-filaments in the tubular substance *a*, and others of a coarser kind in the transparent intermediate substance *b*. Some of the more minute tubuli in the clear substance are fungus-filaments, whilst others belong to the shell itself. × 360 diam.

8.—From the skeleton of an *Astræa*. Numerous fungus-filaments with sporangia. × 60 diam.

9.—Fungus growths in the scales of *Beryx ornatus* (Chalk). × 60 diam.

ORIGINAL COMMUNICATIONS.

On the Occurrence *of* Zoospores *in the* Family Desmidiaceæ.

By William Archer.

(Read before the Natural History Society of Dublin, Friday Evening, February 3, 1860; extracted from the 'Natural History Review and Quarterly Journal of Science,' for July, 1860.)

In bringing forward the accompanying drawings, illustrative of the production in the family Desmidiaceæ of what I believe to be Zoospores,—while I have to express my regret that so many links are wanting in the history of their formation and production,—I nevertheless feel confident the observations will be found, even so far as they go, of abundantly sufficient novelty to warrant my drawing attention to them. The singular condition which the figures represent seems to be one of such rarity, so far as I can learn, as to lead me to believe that this will be the first time of any similar phenomenon being either figured or recorded in this family—A. Braun's account of what takes place in Pediastrum (I believe not truly a Desmidian at all) excepted. And although I cannot, perhaps, add much to their value by any accompanying remarks of mine, I shall, however, have indicated, as it appears to me, the direction in which we are to look for, and the mode in which we are to expect hereafter, the production of zoospores, at least in Docidium, which genus furnishes us with the example in question, as well as perhaps in any other Desmidian genus.

This consideration leads me to believe that, before offering anything in the way of explanation of the figures, it would be of importance to draw attention to what is stated in books on the subject of the occurrence of zoospores in this family. I believe every writer in our text-books on microscopic organisms, when touching on Desmidiaceæ, states it as a fact, that, like various other algæ, they are propagated by zoospores; while some go more or less into details, I am induced to say, very deferentially, that I think the descriptions

or statements often given are based rather on assumption than on actual experience, because (Pediastrum excepted) I do not find authorities given or references made to published figures or recorded observations. Indeed, I am disposed to think it not improbable that, in several instances, what is meant by the authors alluded to is another and, I apprehend, a distinct phenomenon, but which is described as, and, as I imagine, erroneously called, the formation of the motile bodies or active gonidia, known amongst the algæ as "zoospores."

It is indeed likely that, by some, arguing from analogy, the assertion is based on the history of the propagation by zoospores, as it occurs in Pediastrum, as described by A. Braun (*vide* "Rejuvenescence in Nature," 'Ray Soc. Pub.,' 1853). In that genus this process occurs in the following manner, of which it may not be out of place very briefly to remind my hearers:—In this plant the frond consists, as is well known, of a cluster of cells, disposed in a single plane, generally concentrically—the marginal ones laterally and externally, and in some species the innermost also laterally notched. From the cells of this frond the zoospores are not emitted singly, as in numerous other algæ, but the entire number, formed by the subdivision of the endochrome of each into four, eight, sixteen, thirty-two, or sixty-four, or even one hundred and twenty-eight portions, escape from the parent cell, still involved in its inner membrane; and it is within this that they eventually settle down and arrange themselves into a flat cluster, resembling that from a cell of which they themselves originated, each zoospore becoming one of the component, mostly more or less notched or bidentate, cells of the new frond. These spores are called by the German writers "macrogonidia." Other fronds, however, give birth to smaller, more numerous, and more active spores, called "microgonidia," of which the further history after their escape is unknown. Notwithstanding that in all our text-books, in which this genus is spoken of, it is referred to the Desmidiaceæ, I have myself some time since come to the conclusion that Pediastrum is not a Desmidian at all, and I shall endeavour briefly to bring before you the considerations which seem to lead to such a conclusion.

I am, of course, aware of the difficulty sometimes met with in satisfactorily embracing certain organisms within the terms of what may occasionally appear as perhaps somewhat arbitrary diagnostic characteristics; and, while the acknowledged fact cannot be overlooked, that no linear arrangement can ever properly express the whole of the natural and

mutual affinities of organic objects; and while at the same time I will not deny, in regard to certain organisms which seem to be incongruously united with certain groups or families, that it sometimes happens, while our present state of knowledge as to their nature and history is deficient, that it is more advisable to allow the puzzling forms to remain combined with such groups as may appear temporarily the most convenient; nevertheless, if any organism be found really not to agree with the characters which are common to and appear to pervade an apparently perfectly natural assemblage, it would seem to me to be repugnant to a proper classification, if it could be avoided, that it should be therewith associated.

I shall, then, venture to delay, before entering on the subject proper of this communication, by drawing attention to the diagnosis of this family, as given in Ralfs' monograph, "The British Desmidiæ:"—"Fresh-water figured mucous and microscopic algæ of a green colour. Transverse division mostly complete, but in some genera incomplete. Cells or joints of two symmetrical valves, the junction always marked by the division of the endochrome, often also by a constriction. Sporangia formed by the coupling of the cells and union of their contents." Although I have no new observation in regard to the history of Pediastrum to add, I shall just briefly compare that genus with the foregoing definition.

That Pediastrum agrees with the first clause of Ralfs' diagnosis is indeed apparent.

In regard to the second clause, so far as I can make out, I believe the complete fission into two distinct cells of any of the component cells has not been observed; that is to say, I believe the number of component cells in any particular frond is not increased after their first formation; in other words, there does not appear to be any extension of the cell-wall of any cell accompanied by a transverse fission. Mr. Ralfs mentions that he did not see cell-division. I have certainly myself, so far as my own limited experience in this genus goes, never noticed anything to indicate the mode of division characteristic of the Desmidiaceæ. By this, of course, is not meant to be denied the subdivision of the endochrome within the parent cell,—the necessary prelude to its conversion into zoospores. The number of constituent cells in a frond, of often indeed even the same species, seems, therefore, to depend on the number of times the original endochrome of the parent cell had become segmented, and the consequent number of zoospores. Occasionally a frond

may be met with in which one of the component cells is about double the dimensions of the others, while the normal number is deficient by one; indicating, not the special increase in size of one of the cells, as compared with the others, but rather that the ultimate segmentation of the endochrome within the original parent cell, preparatory to being converted into zoospores, was in this one instance not fully carried out. Sometimes a few marginal cells are wanting, which may, perhaps, be explained in the same manner; sometimes, however, they become accidentally removed by external forces. Indeed, it is hard to suppose an increase in number of the constituent cells of a frond without its becoming altered from a plane to an irregular structure, such as takes place in Monostroma, Ulva, &c., the dimensions of the frond itself, however, expanding by a simultaneous increase all over. If I be right, then, Pediastrum does not coincide with the second clause of Ralfs' diagnosis.

As to the next clause, an inspection of any species of Pediastrum will manifest that the cells are not composed of two symmetrical halves, and that in the empty cells there is no evidence of a suture; unless, indeed, the slit or gash occurring in those cells which have produced zoospores, and by which they have escaped, be an indication of its existence, while they are characterised by merely being bidentate at the external margin of often the outside row of cells only, the internal being frequently of undefined outline.

Lastly, so far as I am aware, conjugation has never been seen in this genus. I have myself noticed in *Pediastrum Boryanum* the cell-contents of certain marginal cells retracted from the external wall, and massed together into a green, smooth, orbicular, spore-like body [resting spore?] in the centre. But as this took place, not in the neighbouring cells, and no cells being empty or disturbed in form, it could not be imagined to be any process of conjugation effected by the transmission of the contents from one neighbouring cell to another.

The diagnosis given by Berkeley, in his 'Introduction to Cryptogamic Botany,' is as follows:—"Cells void of silex, free, or forming brittle threads or minute fronds, increased by the formation of two new half cells in the centre, so that the two new cells consist each of a new and old half cell. Spores generated by the conjugation of two distinct individuals." The only point of difference in the above definition from Ralfs' is the introduction of the characteristic of the two new half cells during division being interposed between the old ones; but as in a few species this can only be a matter of

just inference, not of direct proof, but of which indeed there cannot be any reasonable doubt, it cannot always be insisted on. But as to Pediastrum, I have before intimated that, so far as I can see, the component cells do not increase in number at all, and therefore in that respect cannot agree with the terms of either diagnosis.

The figured outline of the cells, often, however, confined to the marginal series, yet wanting as they do bilateral symmetry, seems then the reason why Pediastrum has been placed amongst the Desmidiaceæ. But, whilst arguing against the claims of this genus, as such, I own I am myself unaware of where else to place it. Its affinity with *Hydrodictyon utriculatum* seems sufficiently striking. That plant, with what, however, must appear questionable propriety, has been associated with the Siphonaceæ ('Micrographic Dictionary'), a family of which Vaucheria may, perhaps, be assumed as typical. Possibly Pediastrum and its allies, with Hydrodictyon, may prove a distinct family near Volvocinaceæ, with which they seem perhaps connected through Pandorina and Gonium, by certain points of similarity in their development, or in which at least certain parallel phases seem noticeable.

I had written so far of the present paper some months back, and have read it as I then wrote it. Since then I have met with Nägeli's 'Gattungen einzelliger Algen,' also Al. Braun's 'Algarum Unicellularium Genera nova et minus cognita,' where I learn that the views of Nägeli and Braun were identical with the conclusions that had forced themselves on myself, and that those distinguished algologists had actually long since seen fit to remove Pediastrum and its allies from Desmidiaceæ, and have transferred them meantime to the more humble family, Palmellaceæ.

While, then, the object of this paper is to prove that what I think must be looked upon as zoospores *do* occur in at least one species in this family, and, consequently, *may* occur throughout, and that our books are therefore not wrong in assuming it (leaving Pediastrum out of the question), still I am inclined to think, as I before indicated, that the statements alluded to are founded rather on the occurrence of what I am disposed to imagine a distinct but, perhaps, more unaccountable phenomenon, than on any published record of what can be looked upon as true zoospores, Pediastrum excepted. I allude to what has been called the "swarming movement" of the ultimate granules of the cell-contents, a phenomenon of common occurrence in this family. Indeed, I believe I have myself noticed it more or less frequently in nearly every species I have seen, and even in those undergoing division. It seems

of more general occurrence in specimens for some time kept in the house; yet, frequent as it is, it is difficult to describe, and almost requires to be seen to be understood. It consists of an active, tremulous, vibratory, dancing kind of motion of the disintegrated endochrome, broken up into an immense number of exceedingly minute non-ciliated granular particles, at once innumerable and, I apprehend, immeasurable. Notwithstanding all the commotion, there is no very great change of place in the active granules themselves. They not unfrequently form a dense cluster together, so crowded as to appear a black mass. Sometimes I have seen these masses of active granules abruptly bounded on one side by a straight line, as if there were some invisible barrier preventing their assuming a more scattered appearance (I have tried to represent this in Fig. 1); but shortly this abrupt line becomes broken, and the cluster loses this appearance, and becomes gradually thinner. I have noticed a very similar movement, though less active, in various other algæ, and in germinating spores, which had already commenced to elongate. Amongst the Diatomaceæ (in *Epithemia turgida*, and in a species of Cymbella), I have seen the endochrome throughout the frustule to each extremity entirely disintegrated into nearly equal and extremely minute and free particles, and these exerting a very vigorous, tremulous, dancing movement, perfectly identical with what is alluded to in the Desmidiaceæ, and, so far as I can see, in no way to be mistaken for the movement of the bodies described by the Rev. E. O'Meara in *Pleurosigma Spencerii*—(*vide* Proceedings of last session, 'Nat. Hist. Rev.,' vol. v, p. 192), alluded to, however, as anthozoids, but more probably zoospores), and in *Epithemia Argus*, *E. gibba*, and *Cocconeis pediculus*, at our last meeting. A similar movement of the ultimate granules, which appear brown and quite dead in various organisms, is sometimes noticeable. This, then, in all such examples I should be inclined to imagine is a manifestation of the phenomenon called "molecular movement," similar to that noticeable in the granules of the fovilla of pollen in the flowering plants, or to that seen when a small portion of the substance of the common fresh-water sponge is crushed down and viewed under the microscope (and of this other examples might be cited), and rather in the cases so common in the Desmidiaceæ, and in the very rare examples referred to in the Diatomaceæ, indicative of decay, than as the precursor of a further developmental change. I do not, of course, include the singular movement of the free, active particles at the extremities of Closterium, Docidium, &c., which, as every specimen of the species in which it occurs

exhibits it, must be normal; this may, however, possibly be due to some modification of the same molecular law, combined with internal currents.

In alluding to internal currents I may mention that I believe this phenomenon occurs in a greater number of Desmidian species than is generally supposed, but ordinarily in very many it seems to be very rare. *Closterium Lunula* and *Penium digitus*, as is well known, scarcely ever fail to show it. But, besides, I believe with care it can be sometimes seen in other species of Closterium, as well as other genera besides. I have never seen the rotation, as it is called, more vigorous or more active in any vegetable cell than I have sometimes, though by no means always or often, seen it in *Closterium didymotocum*, where the granules, carried onwards by the current, chased each other, with great vigour, round and round the margin of the cell, up one side and down the other, in a manner scarcely comparable to the fitful and irregular currents in *Closterium Lunula*. Again, in *Micrasterias denticulata* I have noticed a few loose granules carried by the current, to travel up and down from one subdivision of a lobe to another, following thus the very zigzag course produced by the deeply incised margin of this species for two or even three of the subdivisions; when, not being then carried any further round the margin, they were diverted again towards the middle of the frond and joined in the *quadrille* (I can think of no better word) there performed by other free granules, until, perhaps, again carried off to the margin, or a few different granules being drawn off in their place. I have noticed similar circulating currents in *Cosmarium Ralfsii*; in this species, however, the segments, unlike Micrasterias, being not incised, the granules were carried round and round in an uninterrupted stream. This vigorous current, however, is very rare; yet I half think I have been able to see currents of the fluid contents in certain Closteria and others, where, at least, it was not evidenced by its carrying any granules with it. But, be this as it may, although I have very frequently witnessed the phenomenon of the active vibratory particles alluded to in very many species, I have never once seen them escape by any normal process. It is true, that when the frond is artificially ruptured, they still, for a time, maintain their movement, though generally less actively; but I have also noticed many of the granules of the general mass of cell-contents, broken up by pressure, themselves to set up a very similar movement, perhaps not so active, though before, of course, they were still.

But if further evidence were wanting to prove the point in

question, I will mention what to me appears to be conclusive; and that is, that in a number of specimens of *Cosmarium* (*Euastrum?*) *sublobatum*, also of *Cosmarium Botrytis*, which had been "mounted" a fortnight, and which we must suppose to have been *dead*, I have witnessed the granular cell-contents exhibiting the "molecular" movement as actively as it occurs in the living frond; and this might have been kept up while I write, possibly, had not the preparation become spoiled at the end of the period mentioned.

Such, then, is, I apprehend, the phenomenon which may have given rise to the following passages: 'British Desmidiæ,' p. 9, Introduction: "When the cells approach maturity, molecular movements may be at times noticed in their contents, precisely similar to what has been described by Agardh and others as occurring in the Confervæ. This movement has been aptly termed a swarming. . . . When released by the opening of the suture, the granules still move, but more rapidly and to a greater distance. With the subsequent history of these granules I am altogether unacquainted, but I conclude that it is similar to what has been traced in other algæ." This brief passage is all Mr. Ralfs, in his work, has to say on the subject; but, although cautiously expressed, it would appear he looked on these minute granules as probably zoospores, and it is, undoubtedly, the same phenomenon to which he alludes. Hassall, 'British Fresh-water Algæ,' p. 340:—"The second method is, assuredly, the usual and legitimate mode of reproduction, viz., that by bodies analogous to zoospores." This statement surely appears to be founded on the molecular movement of the minute swarming granules, as Braun's account of the phenomenon in Pediastrum was not then published. It may, however, be based on Morren's account of the development in Closterium, to which I shall presently allude.—Berkeley, 'Introduction to Cryptogamic Botany,' page 121:—"Another mode of increase is from the swarming of the grains of the endochrome, which becomes individualized as in other algæ, and so give rise to a new generation. These bodies are figured, with filiform appendages, in *Pediastrum granulatum*." The first sentence of the foregoing seems to infer that the author looked upon the swarming granules as zoospores, but it is, perhaps, explained by the second, and the statement may be based on what occurs in Pediastrum.—Carpenter, 'The Microscope and its Revelations,' 1st ed., page 291:—"Many of the Desmidiaceæ multiply after another method; namely, by the subdivision of their endochrome into a multitude of granular particles, termed *gonidia*, which are set free by

the rupture of the cell-wall, and of which every one may develop into a new cell. These 'gonidia' may be endowed with cilia, and many possess an active power of locomotion, in which case they are known as 'zoospores;' or they may be destitute of any such power, and may become enclosed in a firm cyst or envelope, that seems destined for their long-continued preservation, in which case they are designated as 'resting spores.'—The movement of the zoospores, first within the cavity of the cell that gives origin to them, and afterwards externally to it, has frequently been observed in the various species of Cosmarium, and has been described under the title of the 'swarming of the granules,' from the extraordinary resemblance which the mass of moving particles bears to a swarm of bees. The subsequent history of their development, however, has not been fully traced out; and this is a point to which the attention of microscopists should be specially directed." With great diffidence, I venture to suggest that the statements in the foregoing passage must be based on the swarming movement of the minute granules which I have endeavoured to describe above. I am disposed to believe that the granules which the author terms gonidia are not ciliated; and, although the species of Cosmarium often show the movement, it is by no means confined to that genus, but may be frequently seen also in multitudes of other species. The author then goes on to describe the formation of undoubted zoospores in Pediastrum. As to "resting spores," I imagine he must allude to such bodies as are figured by Ralfs in *Desmidium Swartzii* ('Br. Des.,' tab. iv, f.), where they are not produced by conjugation, but seem to be due to the consolidation of the contents of each individual joint, which becomes enclosed in its own special envelope, as sometimes takes place in Spirogyra, &c. Braun suggests that the filament met with by Ralfs may have been one which had entered into conjugation with another filament, and that the string of empty cells had been torn away; but this is certainly not the case, for I have myself met with the species in question in some abundance in precisely the same condition as that figured by Ralfs, and which consist in the cell-contents of a greater or less number in immediate succession of the cells of certain filaments becoming retracted to the centre of the cavity of each cell, and becoming there massed together into a definitely bounded spore-like body, without any process of conjugation or union of the contents of distinct cells. But I was not able to see any further development, and the specimens soon died. (*Vide* also, for resting-spores (?) 'Micrographic Dic-

tionary,' Pl. vi, Fig. 3 B; also 'Proc. Nat. Hist. Soc. Dub.,' 1858-9, Pl. i, Fig. 14—irrespective, of course, of the external abnormal condition).—The 'Micrographic Dictionary' describes only the zoospores in Pediastrum as an *à priori* argument for their occurrence in the Desmidiaceæ generally, assuming, erroneously, that genus as belonging to the family.

A recapitulation of this sort would, however, be incomplete without reference to a communication by M. Ch. Morren in 'Annales des Sciences Naturelles,' tom. v, p. 266, 1836—'Mémoire sur les Clostériées.' In looking over the present subject, I met with Professor Smith's paper on the "Conjugation of *Closterium Ehrenbergii*" ('Annals of Natural History,' second series, vol. v, p. 1), and therefore necessarily with that by M. Morren alluded to; and it seems to me impossible not to coincide in the conclusions of the former on the points in consideration, and consequently to look upon those of the latter as founded in error. I shall endeavour briefly to state the views of Morren, as founded on his observations on *Closterium Ehrenbergii*. He believes that in the mature and merely vegetating plant the endochrome is evenly distributed throughout its entire cavity, and formed of extremely small granules ("utricles"). By-and-by, however, there appears, towards the middle of the frond, one or many darker longitudinal regions, which soon become bands, subsequently changing to be diaphanous, when the "utricles" become larger and spherical, sometimes disposed in a single series, sometimes in several, and these, he says, are nourished and increased in size at the expense of the surrounding smaller granules. These larger "vesicles" he now denominates "propagules," and states they ultimately make their escape from the parent frond by its dehiscence at the central suture, or are protruded, along with the remainder of the endochrome, *en masse* through a pair of apertures on the under side of the frond. But further—he believes that the active granules found at the extremities of this plant (as well, indeed, as in all the species of Closterium, and in some species of a few other genera), preparatory to the emission of his "propagules," leave their position at the extremity of the frond, and, becoming mixed with them, exert a fertilizing function on the latter. The subsequent development of these "propagules" he states to consist in their gradual elongation from their original spherical form; the endochrome, with the gradual increase in size of the now young growing frond, becoming separated into two portions, the terminal spaces with the active granules soon making their appearance as in the

adult Closterium, and further increase in dimensions following, until the full size of the species is attained. He, moreover, describes the act of conjugation (since accurately described by Smith, *l. c.*); but, strange to say, he (M. Morren) does not seem to look upon this as a true generative act, so far as I can judge, but seems to think the sporangium ("seminule") resulting from the act of conjugation is itself fertilized during the process by the agency of the at first terminal motile particles. He states the further development of the spherical sporangium (itself as great in diameter as the old frond), previously undergoing a revolving motion for a few moments, to consist merely in its gradual elongation in two opposite directions, but unequally, thus forming two unequal cones. It is to be supposed, however, that he must imagine the smaller cone would eventually keep up with the longer, so as to restore the symmetry. Such is, briefly, Morren's account of the reproduction in this plant.

Professor Smith (*l. c.*) gives a nearly similar account of the process of conjugation. The conjugative act in this species is not undertaken till after the two original fronds about to conjugate have undergone self-division in the manner usual in this genus—that is to say, by self-fission, effected by a division of the contents into two just under the suture, accompanied by a development of new cell-wall to each old segment, and separation taking place. The separated portions have now one long (and old) cone, and one more blunt and rounded (the nascent younger one). Now, in those individuals about to conjugate, from each of the shorter or younger cones is protruded a blunt, pouch-like projection from the lower and opposed sides of each, which approaching by gradual growth, the contents from each emerge thereby, and, meeting half way, amalgamate with each other; at the same time the other opposite portions of the original parent fronds doing in precisely the same manner. Thus two sporangia ultimately result from the two original fronds, conjugation taking place between each of the opposite individualized pairs of partially old, partially new, fronds—themselves resulting from the self-division of the original parent fronds. A parallel phenomenon is furnished in the process of conjugation by *Closterium lineatum*, as well as by several diatoms. Professor Smith was not able to see any further development of the sporangium, and the propagules of Morren, he believed, had no existence in fact.

I believe the explanation of Morren's statement to be possibly something like the following:—From researches of recent date in regard to the after development of the sporan-

gium in the Desmidiaceæ, it would seem that it is by a repeated segmentation of the contents into a definite number of portions, these becoming set free by the bursting of the cell-wall of the sporangium, and eventually growing larger, and, ordinary vegetable growth supervening, assuming the characteristic form of the species, that the species is itself perpetuated (*Vide* Hofmeister "On Reproduction in the Desmidiæ and Diatomeæ," translated in 'Annals of Natural History,' January, 1858; also, De Bary, 'Untersuchungen über die Familie der Conjugaten, Zygnemeen und Desmidieen,' taf. vi, figs. 12—24, and 35—46). Now it seems probable that Morren's "large vesicles" were but the starch granules common in these species, and that they were set free but by the accidental fracture of the frond; that his germinating "propagules," stated to produce the plant by gradual extension and growth, were most likely germinating sporangia, after the contents had undergone segmentation into a number of separate portions; that the fronds with unequal cones, supposed by him to result from the unequal growth of the sporangium, may have been merely detached and accidentally unconjugated fronds, after having undergone self-division. It is true that this explaining away of his statements leaves the function of the active terminal granules in Closterium still unexplained; but I apprehend the true generative act in these plants is to be sought, and is found, in the act of conjugation itself. But, even admitting the correctness of Morren's account, and that there might be two modes of true generation in these plants, still his "propagules" could hardly be looked upon as zoospores, as these latter bodies, in what I believe the strict and proper sense of the term, do not undergo fertilization at all, and are ciliated and motile. I may remark, it is possible the statements I have quoted from various works may be based on Morren's account just alluded to, yet I do not find references made to his memoir (written in 1836). I may add that Smith (*l. c.*) comes to the conclusion to which I had myself arrived, and which I ventured ere now to express ('Nat. Hist. Review,' vol. v, p. 240), that the swarming particles are not zoospores, and not connected with the development of the species, and I am much pleased to find my own previous ideas coinciding with those of so experienced an observer.

There is only one other record which seems to bear at all on this point, at least which I have been able to gather, and it is questionable whether it refers here. I allude to Ehrenberg's figure, given in his work 'Die Infusionsthierchen,' Plate ii, Fig. 15, where a number of green zoospore-like bodies

are figured within and external to an empty Closterium; these bodies, named by him *Bodo viridis*, and classed amongst the Infusorial ("polygastric") animalcules. Near the centre of the figure, within the nearly empty frond of the Closterium, there is a green, irregular, rugged mass. Could this be a portion of the granular endochrome untransformed into "zoospores"—his animals of the species "*Bodo viridis*"?

Having thus endeavoured to convey what I believe is the state of the question as to the occurrence of zoospores in the family Desmidiaceæ, I will next draw attention to the accompanying figures (Plate XI, Figs. 1, 4). *Docidium Ehrenbergii* here affords us an example of the production of a few comparatively large ciliated bodies formed at the expense of the cell-contents of the parent cell, and which make their exit therefrom through one or more specially formed lateral tubes. These bodies, although I am quite ignorant of their after development, I cannot but believe to be zoospores; and I imagine I am justified in the conclusion, their appearance and mode of formation seems to be so comparable to the zoospores in Cladophora, where they undoubtedly, as is well known in this as in various other algæ, propagate the plant and form young colonies in abundance. The first indication of the commencement of the phenomenon is the production of a single minute hyaline lateral tubercle, or sometimes of two, or more rarely still of three such tubercles, just under the inflation at the base of, I imagine, the younger segment (Fig. 1). This tubercle arises—and the same holds when there are two or three—not from any part of the original segments, but from a special extension of the boundary wall interposed between the inflated base of the segment and the sutural line. In other words, the tubercle is not produced between the segments by their separation at the suture, but from an extension or addition at the base to one only of the segments. On looking at the drawings superficially, it might appear that the new growth, with the projecting lateral extension, was a modification of the phenomenon some cases of which were figured and described by me in our Proceedings of last session (Figs. 10 to 15),* here merely differently carried out with a definite end to meet a special exigency. But the case is different here, for in the abnormal growths alluded to (*l. c.*), the new irregular portions were added between the old segments by their separation at the suture, making a third development specially belonging to neither old segment; whereas here, as I have just indicated,

* 'Nat. Hist. Review,' vol. vi, p. 469, Plate xxxiii, figs. 10—15.

the new addition is an extension to the base of one only of the original segments. The growth of the additional lateral tube in the present instance is comparable rather to the somewhat similar extension from the shorter or younger cone, preparatory to conjugation, in *Closterium Ehrenbergii*, described a little back, except that here it is usually longer (or more than one), and gives egress to separated portions of the endochorme, individualized as zoospores, and not permitting it to extrude *en masse* for the purpose of conjugating with the contents of a neighbouring frond; thus we not unfrequently observe in nature modifications of similar means conducive to different ends. When the segment gives rise to one tubercle only, this additional growth is gradually developed more and more narrowly, diminishing to nothing at the opposite point of the cylindrical segment, so that the frond is thus thrown out of its straight or nearly straight direction, and becomes bent into a knee-shape (Figs. 2 and 3). Such is also the case when two projections arise side by side. But when two originate opposite to each other, or when there are three, the frond is not thrown out of its straight form, because the new addition to the segment, from which these lateral growths take their origin, now forms an annular extension equal all round, and the segment therefore becomes added to in length by just so much as the annular addition is broad—and this is less than the 1-3000th part of an inch (Fig. 4). As the case is pretty similar whether there be one, two, or three of these lateral growths, I shall continue my remarks upon those cases where one only is formed. The basal tubercle now gradually elongates, and becomes a tube in direct connection and continuation with the frond (like the finger to a glove), and is about 1-3600th of an inch in diameter, but of very varied degrees of length (Fig. 2). I have noticed some to cease to grow after having barely attained about 1-10th or 1-8th part of the length of the frond, and I have seen a few very long, almost, if not quite as long as the frond itself. The endochrome near the base of each segment, and in the neighbourhood of the lateral tube, next becomes very finely granular, of an almost homogeneous appearance, and the lateral tube is filled by it. The remainder of the endochrome (even in the state indicated by Fig. 2) is still but little altered from the ordinary condition, and the terminal cavities with the active granules, characteristic of this genus, as well as of Closterium, remain unchanged. The annular addition and the lateral tubes are quite smooth, and destitute of the scattered puncta which characterise the empty frond in this species (Figs. 3, 4).

Now it is, I apprehend, not a little worthy of remark that the swarming, active, disintegrated granules disassociated from the rest of the endochrome, described above as of frequent occurrence, are met with at this stage, as well as frequently at the stage indicated by Fig. 1, when the lateral tube first appears as a mere tubercle; and, moreover, presents precisely the same appearance and conditions that other specimens of this species (*D. Ehrenbergii*) on the same slide exhibit, but which are not destined to undergo the other changes here described. Further, numerous other species, which occurred in the same gathering, presented similar examples of the molecular swarming movement; for example, *Docidium clavatum*, *Gonatozyon Ralfsii*, various Cosmaria, &c. But I think it is not less equally worthy of remark, that other specimens undergoing the peculiar development, of which the production of the lateral tube is a stage, did not indicate any molecular or swarming movement of the minute granules of the endochrome—that in the terminal spaces, of course, excepted. On the whole, then, it does not appear to me that these swarming granules had anything specially to do with the production of the very different motile bodies now to be described.

I have before stated that the endochrome near the base of each segment, and filling the lateral tubes, becomes very finely granular; it next becomes segmented into a definite number of rounded portions, or "gonidia." I was never able to count them exactly, but I suppose they were not less than twenty, nor over fifty; nor did the fact of there being either two or three lateral tubes developed seem to indicate any very great addition to the number of these bodies. That portion of the endochrome not thus transformed into gonidia lying beyond them, and extending to the ends of the segments, by this time loses its normal character, and seems to become drawn into detached bands or strings, with a few free granules, and the terminal cavity, with the active particles, becomes lost. The gonidia lately formed at the middle of the frond have now emerged through the opened apex of the lateral tube, and remain clustered together in a mass very much like a bunch of grapes, the clusters becoming, by degrees, larger and larger, until all the gonidia make their exit through the tube, and each adds its quota to the group (Fig. 3). The same is the case when there are two or three tubes, the only difference being that a fewer number, but generally about equal, make their way through each (Fig. 4). Meantime, the unused endochrome, which had become drawn into detached strings, now loses its bright-green colour,

changing somewhat to an olive, finally turning brown, and quite dying, and even, to a great extent, disappears (Figs. 3, 4). Each of the gonidia forming the external cluster appears by this time to have formed for itself a special cell-wall of slightly compressed or elliptic form, within which the green contents may often be seen somewhat retracted. Now, a movement within its circumscribed prison may be seen on the part of the contents of a few of the gonidia, which takes the appearance of a twisting motion, backwards and forwards as it were, on its axis, similar to what may be sometimes seen in the organisms called Trachelomonas by Ehrenberg. I have not noticed them to turn completely round. These gonidia are, however, greatly smaller, nor could I perceive any red spot. If such a comparison might not appear wholly out of place, I would be induced to say that the movement of the green contents within the confining membrane reminded me somewhat of the movement of the eye in certain Entomostraca. This movement is not apparent in all the whole group of gonidia simultaneously, but only in a few at a time. Eventually, one by one, the green contents leave the confining membrane in which they have hitherto been detained; but my observation being here incomplete, and my avocations calling me away, I am unable to say in what manner they made their exit. There certainly appeared no neck-like opening or perceptible aperture, but they probably emerged by rupturing the boundary wall. Having, however, made their escape, they swim away as ovate or pyriform ciliated bodies, pale at the narrower or pointed end, and green otherwise throughout—in point of fact, veritable motile gonidia, or zoospores, in every way comparable to the similar bodies found in other algæ (Fig. 4); their principal distinction from those, for instance, in Cladophora, being their temporarily abiding in a cluster, each encysted in its special coating. I vainly tried to satisfy myself whether these zoospores were *one* or *two*-ciliated, but I was not able to decide this difficult point. They were about 1-3600th of an inch in their narrower diameter, and somewhat greater longitudinally. Having, one by one, escaped, the vacated cells remain not long attached at the apex of the lateral tube, and I think they fall away therefrom sometimes in a more or less connected condition, and finally decay. The old frond now generally separates at the suture, one segment bearing away the empty special structure described, the other, of course, unchanged; any remaining endochrome by this time being quite brown, broken up, and dead, if indeed it be not altogether vanished (Fig. 4). I imagine it may be possible that in the native

pool the whole of the endochrome might become used up in the production of the zoospores, as the course of nature may have been more or less arrested under the conditions to which the gathering had been necessarily subjected. The empty cell-membranes, or old segments, were to be found for some time afterwards in the gathering, when all traces of the zoospores had completely disappeared; and I may add, that the formation of zoospores occupied only two days when there was a complete cessation of their development. I may also add that the gathering, in which the phenomenon I have been endeavouring to describe occurred, was made in September last.

A glance at the figures will be quite enough, as it seems to me, however imperfect my own description may be, to prove that the phenomenon in question cannot be mistaken for any development of the parasitic growths *Pythium entophytum* (Pringsheim),* or of any species of Chytridium (Braun), although a hurried reading might possibly lead to such a conclusion. These organisms consist of colourless pyriform or flask-shaped bodies, with a more or less elongate neck,—in the former instance originating, in greater or less numbers, within the cavity of the cell attacked, and protruding their necks *through* its external wall,—in the latter, seated externally *upon* it—and both producing and emitting very minute zoospores through their opened apices. Be these curious growths antheridial structures or true parasites, which latter, I apprehend, is most likely, there does not seem much danger of confounding that form placed under Braun's genus Chytridium with the phenomenon in Docidium above described, but a mistake, so far as regards *Pythium entophytum* (Pringsheim), seems, perhaps, more worthy guarding against. For a figure of this plant attacking *Eremosphæra viridis* (De Bary) (= *Chlorosphæra Oliveri*, Henfrey), see 'Micrographic Dictionary,' Pl. xlv, Fig. 8. It has, also, been noticed by Carter attacking the cells of Spirogyra, by Brébisson infesting various Desmidiaceæ, and is sometimes met with in *Closterium lunula*. In Pythium the several distinct parasites seem to be nourished at the expense of the contents of the infested cell, presently protruding their tubular necks through its boundary wall, outside which they burst at their apices and discharge exceedingly minute "zoospores," formed from what has now become their own proper cell-contents, which are not green; whereas, as above indicated in the phenomenon in Docidium, now here for the

* 'Annales des Sciences Naturelles. Bot.,' 4 Ser., tome xi, Pl. 7, fig. 1.

first time described, the tubular extensions are produced directly from an addition to the original cell-wall itself, and with which they are in absolute continuation, and through the apices of which the cell-contents of the frond are emitted by its own direct conversion into zoospores, and which are green and comparatively large, after the manner of Cladophora. Pringsheim seems to see little difficulty in supposing it as easy for the zoospores in Pythium, having arrived at the surface of a suitable confervoid, to penetrate or absorb their way into the cell, as it is for their tubular necks in a similar manner eventually to protrude from within through the outer wall.

I have, however, lately met with a parasitic growth attacking *Closterium lunula*, and which I refer doubtfully to Pythium (Pringsheim), and of which Fig. 5 is a drawing. Pringsheim's plant, met with by him in the conjugated joints of a Spirogyra, he refers to the family Saprolegnieæ. That observer suggests that a ramification of this parasite may exist in the interior, so that the numerous projecting utricles may possibly be connected amongst themselves within the remains of the cell-contents of the infested Spirogyra. Therefore, he says that the bodies with elongated necks may actually be the sporangia, each separated from the vegetative part of the plant by a septum placed deeply beneath the contents of the infested Spirogyra-spore. This, however possible it may be in Pringsheim's plant, does not seem to hold in the curious growth figured (Fig. 5). Here, at least, each individual plant seems to be a flask-shaped body, without any connexion with its neighbours: in one case, indeed, I noticed two of the necks, before penetrating the boundary walls, to inosculate within the frond of the Closterium. In a word, each flask-shaped body, so far as I can see, may be said here to combine in itself both the vegetative, as well as the fructifying portion; the whole plant at maturity being, as it were, converted into a sporangium.

In the earliest condition in which I saw this plant, the bodies within the Closterium appeared rounded vesicles, each with a short neck. The neck of each, by gradual extension, reaches the old cell-wall of the Closterium, penetrating which, it grows to a very considerable extent into the surrounding water. Just within the boundary wall of the Closterium, each shows a very decided globular enlargement of the neck. So far it appears to agree with Pringsheim's Pythium. But it differs therefrom, inasmuch as the cell-contents are *green*, not colourless, as well as in the great length of the necks and in the extremities, while each plant is filled with its endochrome, being distinctly clavate.

Now I regret I am unable to affirm that the numerous orbicular, spore-like bodies in the neighbourhood (Fig. 5) are the produce of the contents of the organism in question, as I did not see their formation — but I cannot doubt it. When I made this particular gathering, I did not meet the Closterium so affected in numbers sufficient to make any definite observations; but I suppose the plants must have given birth to and emitted their contents in the form of the *gonidia* lying about. For, certainly, the bodies scattered around did not occur anywhere else, but always in the neighbourhood of a Closterium containing these organisms; and where they nearly all, or a few only, still contained their endochrome, these abounded close by in the relative numbers to be expected. Admitting them to be such, it may appear questionable whether this growth be connected with the development of the Closterium itself, or whether it be a true parasite. I am disposed myself to think the latter. But, be this as it may, I need hardly insist on the essential distinctness between the phenomenon depicted in Fig. 5, and the condition of Docidium shown in Figs. 1 to 4. It may be well to say that the three ovate ciliated bodies on the Plate near Fig. 4 represent the zoospores appertaining to it, whereas all the other scattered orbicular bodies belong to Fig. 5. Notwithstanding any description I can offer is so very incomplete, I venture to think the drawing itself (a faithful copy from nature) may prove interesting. It seems highly probable that Ehrenberg's genus Polysolenia, included by him and by Kützing in Desmidiacæ (*vide* Kützing, "Species Algarum") must have been truly a Closterium (probably *C. didymotocum*) so attacked. I draw attention here to this very interesting growth, in order to guard against any possibility of its being thought the remarkable condition of Docidium is identical with it, or that I may have myself in any way mistaken the one for the other.

Here, however, my observations conclude, for I am totally unaware of the after development of the motile *gonidia*, the original formation and emission of which I have described. It may be urged that I cannot prove these bodies to be truly zoospores, because I cannot prove they grow into young Docidia, as can more or less readily be done according to the species in various other Algæ, in which the growth of the zoospores into young plants similar to the parent is witnessed with not great difficulty. Possibly the bodies I have described may be but equivalent to those described in some algæ as microgonidia by the German writers; but I cannot for the present see the probability of this assumption, and imagine they are more likely to be true motile buds, *i. e.* zoospores. It will be borne

in mind that the true generative process in *Docidium Ehrenbergii*, like all other undoubted Desmidians, is by conjugation.

Assuming that I am right, the bearing of the fact would not be in the least to affect the acknowledged affinities of this family with their more immediate allies, the Zygnemaceæ, or with the Diatomaceæ; for in the former, in Spirogyra and Mougeotia, ciliated motile bodies, probably zoospores have been noticed; while in the Diatomaceæ, although such a phenomenon had been previously suspected, I need only advert to the researches of the Rev. E. O'Meara (*loc. cit.*), which render it equally probable, if not decided, that such a mode of propagation prevails also in that family.

Such, then, is an account, deficient, as I regret it is, in many points, of what I cannot but look upon, so far as I can make out, as a new and unrecorded phase in the life-history of this beautiful and interesting family, the Desmidiaceæ,—a life-history still obscure in many of its details, but yet one which I aver will not yield in interest to any other portion in the wide domain of our comprehensive science of Natural History, and one also on which I shall deem myself very fortunate and very happy should these humble observations of mine, here recorded, ever be found eventually to shed even a dim and solitary ray of light in its elucidation.

Further Notes on Abnormal Growth in the Desmidiaceæ.

In a former paper read to this Society (*vide* 'Nat. Hist. Rev.,' vol. vi, page 469), I drew attention to an abnormal mode of growth affecting several species of Desmidiaceæ, and I may add that I have since noticed similar cases in two or three other species. This consisted in there being produced between the old segments, not a pair of new ones eventually to become symmetrical with the old, but an irregular, more or less unsymmetrical inflated expansion, forming with the old segments but one uninterrupted cavity; and this kind of monstrosity I endeavoured to show might probably be primarily due to the omission of the formation of a septum as a preliminary to ordinary vegetative growth. In Pl. XI, Fig. 7, I bring forward what seems to be a further extension of the same identical condition of *Arthrodesmus Incus*, as that figured in Pl. xxxiii, Fig. 11, *l. c.* In the case last indicated, as in the others, there must exist a suture between the older segments and the intermediate abnormal growth—that is, the latter has become interposed between the older segments by their separation at the original suture.

Now Fig. 7 of the present Plate seems to indicate that the vegetative energy is not necessarily arrested; for between the central growth (of the *first* case in *A. Incus* figured), and each of the original segments, a new expansion has been formed—the whole, that is, the older segments and the now *three* intervening portions (the middle one being the older) forming still one uninterrupted cavity, and filled with endochrome throughout. The entire structure, under a low power, might be mistaken for a Scenodesmus; but, when sufficiently magnified, its real nature is quite apparent. The specimen (Fig. 7) occurred amongst several others in the condition figured with my former paper (Fig. 11), both mixed with multitudes in the normal state, some in the dividing condition. There does not seem any readily assignable limit to the extent to which this monstrosity might be carried; yet, even supposing it had attained some considerable length, and that the extraordinary structure should survive its own fragility, a time must come, I conceive, as in normal individuals, when the vegetative impetus would be spent, and when, therefore, further increase by mere self-division (in this case, however, abnormally and abortively undertaken) would subside.

Fig. 6 represents a remarkable *mycelioid* growth occurring within a *Closterium lunula*, noticed in the paper alluded to, read to the Society (page 472, *l. c*), remarkable on account of the impossibility, except on Pringsheim's theory in regard to Pythium (*vide* preceding Paper), of accounting for the origin of such a curious internal parasite.

Description of a New Species of Cosmarium, and of a New Species of Xanthidium.

Family.—DESMIDIACEÆ.

Genus.—Cosmarium (*Corda*).

Cosmarium Portianum (*sp. nov.*).

Specific characters: Frond deeply constricted; segments, in front view, broadly elliptic, rough with minute, scattered, pearly granules, constriction deep, wide, isthmus forming a short neck; end-view elliptic.

Locality: Pools, Dublin and Wicklow Mountains; not uncommon.

General description: Frond minute, compressed, in front

view about one third longer than broad, rough all over with minute, scattered, somewhat depressed pearly granules, which give a minutely denticulate appearance to the margin, deeply constricted at the middle, the constriction forming a gradually widening notch at each side, rounded below; segments, in front view, broadly elliptic, in side view, suborbicular, connected by a rather narrow isthmus, forming a short neck; end view, broadly elliptic. (Sporangium, after a figure by Professor De Bary of an undescribed species supposed to be the present: orbicular, beset with somewhat elongate, conical, blunt spines.)

Measurements: Length of frond, $\frac{1}{00}$th; breadth of frond, $\frac{1}{000}$th of an inch.

PLATE XI.—Fig. 8, front view; Fig. 9, end view.

Affinities: The granulated surface and compressed frond in this species forbid its being mistaken for any of those in which the surface is smooth, or the end view circular. Of those species with which it agrees in the characters first indicated, it is about the most minute, and I believe it is otherwise amply distinguished from them by its elliptic segments in front view. It perhaps most approaches *C. margaritiferum* (Menegh.), but, besides its smaller size, it differs from that species and *C. latum* (Bréb.) in not having reniform or semiorbicular segments, as well as in the constriction being not a linear, but a wide notch. The same characters distinguish it from *C. Brébissonii* (Menegh.), as well as the pearly granules being minute and closely scattered, not rather widely distributed and conic. From *C. tetraophthalmum* (Bréb.) it also differs in the same characters, as well as in that of the superficial granules, which in that species are broad, giving the margin a somewhat undulate or crenate, rather than a minutely denticulate, appearance. From *C. Broomei* (Thwaites) and *C. biretum* (Bréb.) it differs, besides other characters, in its elliptic, not quadrilateral or angular, segments. From *C. præmorsum* (Bréb.), *C. notabile* (Bréb.), and *C. Botrytis* (Menegh.), as well as *C. protractum* (Näg.), *C. gemmiferum* (Bréb.), and *C. Turpinii* (Bréb.), it differs in having rounded, not truncate, ends, and from all the species just named in the central constriction, not forming a linear but a wide notch.

It is at once distinguished from *C. orbiculatum* (Ralfs), with which it agrees in the constriction not forming a linear notch, by the segments being elliptic, not spherical, and the end view not circular; besides the pearly granules being minute

and depressed, not elevated and conic. It is true that Professor de Bary ('Untersuchungen über die familie der Conjugaten,' Taf. VI, 49 *a b*) alludes to a Cosmarium called by him *Cosmarium orbiculatum* (Ralfs), which, I apprehend, is actually the species now described, but, with great deference, I think he is wrong; this form differs quite from *C. orbiculatum* (Ralfs), as much, indeed, as *C. bioculatum* (Bréb.) does from *C. moniliforme* (Ralfs). Assuming that I am right in the conjecture that the present species is identical with that alluded to by De Bary under the name of *C. orbiculatum* (Ralfs), the sporangium has been provisionally described in the foregoing specific characters, taken from the figure given by that observer, although I have not myself met it conjugated.

As to other granulate species, so far as I am aware, it needs only to contrast this form with *C. pluviale* (Bréb.), with which it agrees in being compressed, and in the constriction not forming a linear notch, but it differs in the form of the segments, which, in the species just named, are nearly as broad as long, sub-ovate or sub-orbicular, ends rotundato-truncate; whereas, in the species in question, the segments are broader than long, elliptic, and ends rounded, the constriction forming a short neck. Of the smooth species, it most nearly approaches *C. bioculatum* (Bréb.) in form, but the granulate surface of the present species at once distinguishes it. The same circumstance, as well as the want of the solitary superficial projection on each front surface of the segments, separate it from *C. phaseolus* (Bréb.).

I am not aware of any other species with which it seems at all requisite to compare the present form, nor does there indeed appear to me any danger, with proper attention, of confounding it with any of those I have mentioned. This has occurred to me for three or four successive years, and I have no doubt of its distinctness. I have several times been asked the name of this species: to afford a more satisfactory answer than hitherto, the next time the question may be put to me, I have no hesitation in assigning one to this pretty little species.

On a former occasion ('Nat. Hist. Rev.,' vol. v, p. 251) I had the pleasure to name a species, for the ample reasons there given, after my friend, George Porte, Esq. I was not then aware that Professor De Bary, in Germany, had anticipated me; consequently, my name for the species alluded to fell to the ground, and with it much of the compliment I had intended. To restore the latter, I trust the present attempt may be more successful.

Genus—XANTHIDIUM (*Ehr.*).

Xanthidium Smithii (*sp. nov.*).

Specific characters: Segments trapezoid; spines minute, straight, acute, marginal, in four pairs; central projections minute, rounded, tubercle-like.

Locality: Numerous specimens were met with by me on a slide marked "Wareham, 1849, W.S.," kindly lent to me by Professor Harvey.

General Description: Frond minute, in front view about as long as, or very slightly longer than broad; constriction, a deep, gradually widening notch; segments about twice as broad as long, trapezoid, lower margin somewhat convex, sides narrowing upwards and straight, ends broad and straight; spines short minute, straight, acute, marginal, geminate, a pair placed on each of the four angles; in side view, segments about as broad as long, with rounded sides, ends truncate, each upper angle furnished with a minute spine, beneath each of which, about halfway down the segment, there occurs another spine, all the spines divergent; end view sub-elliptic or broadly fusiform, ends truncato-convex, furnished with three spines, the spines projecting, divergent, none at the sides; the central projection from each front surface a minute, rounded, smooth tubercle, apparent always in end view; in the side view the tubercles are sometimes concealed by the projecting divergent central spines, while in the front view they are hidden by the contained endochrome. Sporangium unknown.

Measurements: Length of frond, $\frac{1}{1166}$; breadth, $\frac{1}{1273}$ of an inch.

PLATE XI.—Fig. 10, front view; Fig. 11, side view; Fig. 12, end view.

Affinities: This interesting little species seems to be allied on the one hand to *Xanthidium fasciculatum* (Ehr.), and on the other to *Arthrodesmus octocornis* (Ehr., Hass., Bréb.)= *Xanthidium octocorne* (Ralfs), var. β, but is perfectly and, I believe, unmistakably distinct from either. With the former it agrees in the spines being subulate, marginal, and in pairs, and in the central projection being not granulate; but it differs in its far more minute size, and in its segments being four-sided, not reniform or sub-hexagonal, and in its spines being short, and minute and straight, not elongate and usually curved, and in its constriction not forming a linear notch. With the other species named (var. β) this form

agrees in its trapezoid segments, and in the number and disposition of its spines, but differs in possessing the central frontal projections, which are absent in the species alluded to, and which circumstance, I think, should place it out of the genus *Xanthidium*. The form now under consideration also differs from that alluded to in having its margins straight, not concave; in its spines being minute, not elongate; in the segments, in side view, which is less compressed, being sub-orbicular, not elliptic; in the ends being truncate, not rounded; and in the extremities in the end view being blunt, not rounded. Notwithstanding, therefore, considerable similarity in the general outline between the present species and *Arthrodesmus octocornis*, var. β, I cannot suppose they can be identical. The latter I have not myself met with in this country, but var. α is not uncommon. However, I prefer to follow Brébisson, and to place both those forms in the genus Arthrodesmus, though, perhaps, Jenner's suggestion to form a new genus for them, including, of course, *Arthrodesmus bifidus* (Bréb.), would, after all, be the better course. Certain it is that the plant now described is an unquestionable *Xanthidium*.

I imagine the initials on the slide above alluded to must be those of the late Professor William Smith; it is, however, in any case by no means an inappropriate, though but a small and very inadequate, mark of respect to dedicate this species, which I believe to be very distinct, to his memory.

Contributions *to the knowledge of the* Development *of the* Gonidia *of* Lichens, *in relation to the* Unicellular Algæ, *&c.* By J. Braxton Hicks, M.D. Lond., F.L.S., &c.

Fasciculus 1.

It needs no remarks of mine to point out the extreme ambiguity which exists in regard to the arrangement of both the species and genera of the unicellular algæ and their kindred organisms. Perplexing to the last degree to the older student, to the novice they are bewildering, and highly unsatisfactory to all who, allured by their simplicity of structure, have been desirous of studying Nature on her protophytic threshold.

However, within the last few years an opinion, based on

some valuable observations,* has sprung up—that many organisms of the class alluded to are but a condition of the growth of the gonidia of lichens.

To add new facts to those already published, tending in the same direction, will be the endeavour of the following contributions, and which, it is confidently hoped, will throw additional light on this confessedly difficult subject.

And it may be well at the commencement to remark that the gonidia of lichens have extraordinary powers of dissemination, far beyond what is generally recognised. From a series of observations, extending now over many years, in which they were never absent, I found that they may be collected in comparatively great numbers from snow and rain, particularly the former, and especially in windy weather. The quantity of gonidia, frequently with attached fragments of lichens, entangled and brought down by the snow, generally considerably exceeds that of any other organic molecules.

Experiments upon this point may be easily made by placing a clean sheet of glass in the open air during a fall of snow. When a sufficient quantity has fallen, it should be melted, and the snow-water allowed to run into a tube; the supernatant fluid being poured off after the foreign matter has subsided, I have noticed sometimes that the discoloration of the water is in a great measure dependent on the *gonidia* of lichens. These I have kept in the water for some months, and have seen them passing through the same varieties of segmentation to be described below as occurring in the gonidia of lichens and in "*Chlorococcus*." Hence it will be seen that every surface upon which snow or rain can fall must have a number of these gonidia deposited upon it during the year. In the course of the following communication it will be seen that these organisms have the property of increasing to an unlimited extent by subdivision, and thus will be explained how enormous surfaces are covered by the so-called "*Chlorococcus*."

Now, although the gonidia of the various lichens are wafted by air-currents hither and thither, doubtless to very distant points of the globe, yet we may for the same reason expect the unicellular algæ and their allies, if really derived from them, would, in any given district, vary according to the species of lichens prevalent in that district; and this I have found, so far as my observations have extended, to be the case; for although the gonidia of many lichens are scarcely to be distinguished from each other, yet there are,

* See 'Botanische Zeitung,' 5th January, 1855, I. H. Ibid., 1855, Herm. Itzigsohn. 'Microscop. Dict.,' art. "Palmellaceæ."

in many, constant minute differences, visible to a practised eye, while in some there are essential variations during their growth, which will be noticed hereafter.

After these remarks I will pass to the consideration of that unicellular plant, commonly called "*Chlorococcus*," which covers with a green coating, walls, trees, palings and indeed any exposed body rough enough to give attachment to it.

It is, in its mature, quiescent state, a round, globular cell (fig. 1, *a*, *a*), consisting of a cell-wall, with green cell-contents, having a nucleus in its centre. It is shown highly magnified at fig. 3. These cells may remain in a dormant condition for a considerable time during cold weather, but upon the return of warmth and moisture they begin to increase in numbers, by a process of subdivision which varies in the different cells.

Sometimes the mass of contents divides into from two to eight or more portions, which soon assume a round form, and burst the parent cell-wall open; or the septa radiate from the centre; these secondary cells soon begin to divide by binary and quaternary division, and this process may go on for a very long period, even for years, without much variation. The size of these divisions varies according to the rapidity with which the process of segmentation exceeds that of individual cell-growth (Pl. X, figs. 1, 2). Ultimately, however, they all assume the form and size of the parent round, nucleated cell.

Now, the gonidia of many of the lichens are *precisely similar*, both in the mature, quiet state, as also in the active process of multiplication, and are of the same size. This is well seen in making a section of the thallus of any ordinary lichen about to undergo what is called "soridiferous degeneration—for instance, of *Parmelia parietina*. The gonidia, increasing beneath the cortical layer by subdivision, at first elevate in parts the layer above it, till at length they burst through, and then at first appear of a green colour, continuing the process of subdivision in a manner indistinguishable in every respect from the "*Chlorococcus*" before described. For this reason it has been suspected by some recent investigators that the latter is possibly derived from the gonidium of the lichens.

The additional facts I shall bring forward will, I conceive, set the question affirmatively at rest.

It will, therefore, be necessary to watch the true gonidium a stage further, while still resting on the thallus through which it has burst. After the process of segmentation has been repeated an uncertain number of times, and the divisions

have again become full-sized and globular, it begins to make the first step towards the formation of the felted fibres of its parent, and it will be observed that a small, colourless, tubular projection appears at one spot on the surface of the cell-wall (fig. 2 *a*), which, increasing in length becomes a tubular fibre, which, whilst adhering closely to the exterior of the cell, and articulated and branching (fig. 2, *b*, *b*, *b*), at last completely encloses it by its ramifications, which vary in colour. In the case of *Parmelia parietina* they are yellow, and the round mass, opaque by transmitted light, and rough on its outside in consequence of the branches of the fibres not closely adhering by their ends, is denominated a "soridium." This gives the powdery appearance to the surface of the lichen upon which it rests, and has a considerable influence on the general colour of the plant, which thus depends on the amount and colour of these enclosing fibres.

The *soridium* may remain in this stage for an indefinite period —for months, and, I suspect, even for years—in which event the case produced by the branching, adhering fibres becomes thickened and denser, as shown at fig. 9. This is generally more apparent during the colder months, and is probably a means of protection.

When segmentation commences within this *soridium*, it often results in a very large number of subdivisions, as at fig. 10, *a*, and the fibres, passing inwards between the segments, separate them, while the whole ball enlarges, so as to produce the first commencement of a *thallus*. This point is of importance, as will be remarked upon when we come to speak of the corresponding stage in the "*soridium*" of *Cladonia*. But segmentation of the enclosed gonidium may proceed simultaneously with the fibre-growth, in which case the *soridia* assume the appearance shown at figs. 4 and 5. Frequently the subdivisions become oval and small, undergoing binary segmentation. Fig. 6 represents an instance of this, in which the parent cell-wall is still seen partly dissolved. Fig. 8, *a*, also shows this form. In others they are globular from the commencement, and simply increase in size, as at figs. 4, 5, 10, *b*, *b*, till they are as large as the parent cell.

The contents of one of these broken soridia is shown at fig. 8, with fibres branching among the segments.

Precisely the same changes take place in the so-called "*Chlorococcus*." As I said before, the multiplication by division may proceed during an indefinite period; however, circumstances favouring the tendency to form the fibre commences, and a "*soridium*" is the result. To describe these changes would be but to repeat the above remarks on the

process in the undoubted gonidium of the lichen. If a portion of the bark of a tree on which the *Chlorococcus* is growing be placed under glass, so as to keep it in a moderately moist atmosphere, the phenomenon may be observed in all its changes. It may also be traced perfectly in nature, and may be recognised by lighter-coloured patches, appearing where "Chlorococcus" has been growing. That the change of colour is caused by the growth of the fibres may readily be seen on microscopical examination; and this point is instructive, because it will be found that the colour varies notably according to the lichen prevalent in its neighbourhood. Where the yellow Parmelia is found, the "Chlorococcus" will assume a yellow tinge in its soridial stage. Viewed by transmitted light, they are also opaque balls, with irregular outline (fig. 7).

But it must be clearly understood that every Chlorococcus does not follow exactly this course, for I shall show marked exceptions; but it obtains with the generality; and it is a remarkable fact, that when "Chlorococcus" does vary, it is in the neighbourhood of those lichens whose gonidia also vary, and in precisely the same manner.

That this "Chlorococcus" stage does continue for a long period without showing any disposition to form soridia, constantly multiplying till large surfaces are covered, and to some depth, may be plainly observed; and this, taken with what I have remarked before, will explain its almost universal presence. This condition seems to be favoured by cool, moist weather. The soridia also remain dormant for a very long time, and do not develop into *thalli* unless in a favorable situation; in some cases, I think, for years. It will be easily perceived that the soridium contains all the elements of a thallus in miniature; in fact, a thallus does frequently arise from one alone, yet, generally, the fibres of neighbouring soridia interlace, and thus a thallus is matured more rapidly. This is one of the causes of the variation of appearance so common in many species of lichens, and is more readily seen towards the centre of the parent thallus. When the gonidia remain attached to the parent thallus the circumstances are, of course, generally very favorable, and then they develop into secondary thalli, attached more or less to the older one, which, in many instances, decays beneath them. This process being continued year after year, gives an apparent thickness and spongy appearance to the lichen, and is the principal cause of the various modifications in the external aspect of the lichens which caused them formerly to be misclassified.

Summary.—I think, then, from the above remarks, that there can be no doubt but that what has been called "Chlorococcus" is nothing more than the gonidia of some lichens, which, having been conveyed by the movements of the atmosphere, had been deposited on a favorable surface, where they soon begin to increase by various modes of segmentation, which continue for an unlimited period. But under suitable conditions, chiefly drought and warmth, the gonidium throws out from its external envelope a small fibre, which, adhering and branching, ultimately encases it and forms a "soridium." At this stage gonidium may continue also for an indefinite period in a dormant condition, but, circumstances favoring, segmentation of the gonidium goes on within the soridium, while the branches of the fibre penetrate within the divisions, till at last a young thallus is formed. But a check may occur during any of these stages, and yet vitality be prolonged for a period of months and even years.

Of this, I believe, any one may satisfy himself if he will be careful to watch an old wall or tree, and check his observation by the microscope from time to time. In every particular, the whole of these stages are passed through by those gonidia whose pedigree is known, which, having burst through the cortical layers of the lichen-thallus, still remain attached to its surface.

There are two other points which, although they require more observations to give any certain value to them, it will be as well to mention here:

The first is the occurrence among the fibres of dilatations which contain a number of small, actively moving bodies, of a reddish-brown colour (as at fig. 11, *a*, *a*). They apparently have a motion different from the ordinary molecular movement.

The other is, that there are to be found among the crushed *soridia* some small, moving, green cells, like minute zoospores, but I cannot satisfy myself as to their origin.

On CYCLOTELLA.

By G. A. WALKER-ARNOTT, LL.D.

MY object is not to give here a monograph of the genus *Cyclotella*, but to endeavour to clear up the synonyms of our British species, which to me appear to be in a little confusion.

C. Dallasiana was described by the late Professor Smith from a single specimen; he characterises it by the disc cellular; his slide, now in the British Museum, has been carefully examined by Mr. Roper, and the valve identified by him with specimens he has obtained from the Thames. The disc or portion of the valve within the striated margin is not areolate, as may be inferred from the term "cellular," but merely minutely bullate or puckered, or as if blistered, on account of numerous little elevations and depressions; perhaps bullate-rugose is the most expressive mode of description.

What Smith had seen is the large form, and probably the sporangial state of the diatom; but there is another form of it, much smaller (with occasionally the large one sparingly mixed), which I have long ago had sent me by Mr. J. T. Norman, No. 178, City Road, London. This small one appears to be not unfrequent about Woolwich, although it has not as yet been obtained in a sufficiently pure state to afford good slides. If attention be not paid to the bullate, but otherwise flat, and not projecting or undulate, smooth centre, this may be readily mistaken for a state of *C. Kutzingiana*, Sm.; and I have no doubt whatever that it forms *C. Kutzingiana* β of Smith, as far as the British localities are concerned, although quite distinct from the synonyms adduced. Like *C. Kutzingiana*, it only occurs in brackish water.

Smith states that *C. Kutzingiana* is met with in fresh and brackish water; I have never seen the true species from fresh water, and believe that he added this kind of locality from erroneously supposing that *C. rectangula* of De Brébisson, or *C. operculata* β of Kützing, which is a fresh-water species, was the same as his *C. Kutzingiana* β. Specimens, however, of *C. rectangula*, De Bréb., from De Brébisson himself, and a portion of the only gathering he ever made of it (near Paris), prove that diatom to be no way distinct from *C. Meneghiniana* of Kützing, a species allied to *C. Kutzingiana*, and having the same coarse, marginal striæ; but differing by the flat, not undulate, ends, and by its fresh-water locality.

What is called *C. operculata* presents two forms, both figured by Kützing. One has the centre of the valve smooth and projecting obliquely (as in *C. Kutzingiana*), forming, as it were, a sort of operculum or convex lid to the valve, the projecting portion of the one frustule corresponding to that of the contiguous one which does not project, thus presenting an undulate appearance on the front view; to this the name *operculata* properly belongs. The other has a flat (not pro-

jecting) disc, but the disc is marked by radiating dots or lines. Smith, in his 'Synopsis,' had both in view: the first, or true *C. operculata*, he has described with sufficient precision, although, in place of being concave or *depressed* in the centre, as he says, I consider it to be convex or elevated; the second form is the one which he has figured in Tab. v, fig. 48, and is also that which he distributed in his Lough Neagh slides; it occurs near Ulverstone and Hull, and is probably not uncommon.

Besides the above, Kützing has a species from the Lunneburg deposit, which he calls *C. minutula*; this occurs in many deposits in this country. It is this which Smith obtained from the Lough Mourne deposit, but which he has unfortunately referred to *C. antiqua*, a species which does not occur in any of the Irish deposits which I have examined. The largest and finest specimens of it which I have seen are from the extensive deposit near Toomebridge, between Lough Neagh and Lough Beg, and that from Loch Leven, Kinross-shire, in both of which it is mixed with *C. Rotula*, Sm.

On carefully comparing the *C. minutula* from deposits with the second form of *C. operculata*, I have little doubt of their identity; both have got the same kind of centre to the disc. It seems to have a double coat of silex near the margin, or at least two surfaces differently marked; the upper one presents a series of short, close, marginal striæ, resembling a narrow, striate, convex ring, surrounding the flat disc; the under one is flat, broad, and conspicuously striate from the margin to the central portion or disc. Such are the appearances presented when both states are perfect; but when the recent form (usually confounded with *C. operculata*) becomes abraded or much macerated, it seems to pass into the other; my impression, therefore, is that the one got in deposits (or *C. minutula* true) assumes its distinctive appearance solely by long exposure and maceration, and that it and the recent one (Smith's tab. v, fig. 48) ought to be united. The name of *minutula* is certainly objectionable, as the specimens, even when in deposits, are often so large that they might be mistaken for a small form of *C. Rotula*; but changes of specific names lead to confusion when not transferred to another genus, and it is therefore preferable to retain that given by Kützing.

These five may be comparatively distinguished from each other thus:

1. *C. Dallasiana*; ends of frustule flat; centre of valve bullate-rugose, marginal striæ coarse.

2. *C. Meneghiniana*; ends of frustule flat; centre of valve neither striate nor bullate; marginal striæ coarse.

3. *C. Kutzingiana;* ends of frustule undulate; centre of valve convex, but neither striate nor bullate; marginal striæ long, coarse.

4. *C. operculata;* ends of frustule undulate, centre of valve convex, but neither striate nor bullate; striæ short, close.

5. *C. minutula;* ends of frustule flat; centre of valve with radiating dots or striæ.

To *C. Dallasiana* I refer *C. radiata* of Brightwell. I possess what I consider to be *C. Meneghiniana* from a stream that empties itself into Bidston Marsh, Cheshire, where it was collected in August, 1858, by Mr. T. Comber; but it is not noticed in his "Catalogue of Liverpool Diatoms," 'Mic. Journ.,' viii, p. 113), unless it be what he calls *C. Kutzingiana*, β.* Mr. G. Norman, of Hull, has also found it in the pond of the botanic garden there, and in some other places about Hull; but in all these localities it is very sparse, and much mixed with other diatoms. I have not seen a good frustule with the front view from England, but I do not think that any doubt can be entertained about the species.

C. Rotula, Sm., from deposits, sometimes approaches closely to *C. minutula*, but has distinctly moniliform striæ, and when recent has a series of small, broad-topped, nail-like, spinous processes close to the margin, and perpendicular to the surface of the valve; these are easily broken off, and this affords one of the many arguments against drawing up specific characters from specimens obtained from deposits; the latter may, by ocular comparison, and even by written characters, be frequently correctly referred to the recent form, but recent ones can rarely be satisfactorily determined from descriptions made only from the abraded state. *C. Rotula*, Sm., is *C. Rotula*, Kütz. ('Bac.,' tab. ii, fig. 14); but as Ehrenberg had already described a *Discoplea Rotula*, and also a *Disc. Rota*, both from the South Seas, which Kützing afterwards supposed to be also species of *Cyclotella*, he, in his Species Algarum, changed his former appellation from *C. Rotula* to *C. Astræa*. This change was uncalled for, as the first diatom described under the *combined names* of *Cyclotella Rotula* is that of Kützing, and that name has been adopted by Smith; to it the name *Rotula* ought still to be attached, unless we take into con-

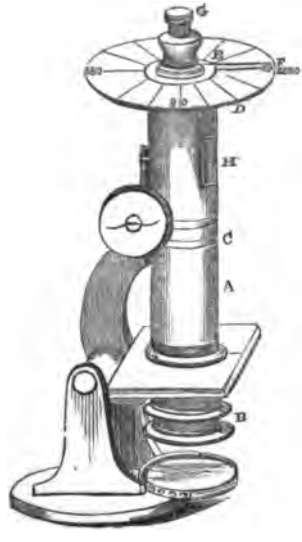
* Catalogues of names are of very little use when not accompanied with diagnostical remarks taken from the specimens collected; for if the writer makes a mistake, as all may readily do in microscopical objects, there is no way of ascertaining what was intended.

sideration that Kützing himself made the alteration before Smith published his 'Synopsis,' although Smith was unaware of it. To this species must be referred *Stephanodiscus Niagaræ* of Ehrenberg, and perhaps also his *S. Egyptiacus*.

The Saccharo-Polariscope.

By William Hendry, Esq., Surgeon, Hull.

The instruments usually figured as employed in the polarization of saccharine solutions are, for the most part, of costly and complex character. Having experienced a little curiosity in the subject, induced through a desire to investigate diabetic urine microscopically, I had occasion to refer to an article contained in 'Morfit's Chemical Manipulations;' and, in pursuance of the methods therein described of Professor M'Culloch, Soleil, Clerget, and others, I have been enabled to fit up an apparatus which will be found efficient, convenient, and inexpensive, whereby the beauteous phenomena of *right-* and *left-handed* polarization indicative of cane or grape sugar may be readily exhibited, or the arcs of prismatic coloration measured, as occasion may require.



I am indebted to Mr. Rowney, of Hull, for the accompanying drawing, representing the arrangement of the apparatus.

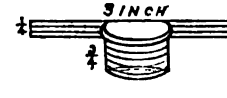
First, procure a gutta-percha tube A, of a calibre to receive the ordinary B eye-piece (which might be in demand for other uses), and about 10 inches in length; fix upon its lower or distal extremity a disc of clear glass between two layers of gutta percha cemented by heat, and perforated to transmit the polarized beam of light, the polarizer B, as usual, being

fixed below the stage. The tube thus prepared is to be substituted for the body of the microscope, and retained by one or more elastic bands c to the stand-frame, and placed in a vertical position for use, resting close upon the stage.

Secondly, fit the top of the gutta-percha tube with a turned wood stopple (not seen in the drawing), 1 inch in depth, three fourths of which should enter the tube moderately tight, just so as not to rotate, and one quarter should constitute a collar or rest, say of 3 inches diameter, overhanging the tube, for convenience of handling on removal, &c., and let this stopple be perforated in the direction of its axis, with a $\frac{6}{10}$th- or $\frac{7}{10}$th-inch aperture; then fix also permanently upon its upper surface a compass card D, marked in degrees of a circle, and with a corresponding perforation.

Now prepare another stopple, E, of 1 inch in depth, and 1¼ inch broad at the bottom, tapering to 1½th inch above, and perforated as before; let this be mounted upon the first stopple, interposing the compass-card and a circular slip of card or two to facilitate rotation, having a needle, F, inserted laterally as an indicator to denote the arc of polarization. (The two stopples may be turned out in one, and afterwards cut across).

A piece of brass tubing, such as is used for jointing fishing-rods, of about 2 inches in length, should be fitted firmly in the perforation of the upper stopple, but made to rotate freely within that of the larger or under stopple, thus allowing the indicator to be turned freely, and without disturbance to the compass-card. The analyser G, as usually employed above the objective in ordinary polarization, is now placed within the upper part of the brass tubing, projecting half an inch above, and lightly packed with gutta percha, so as to have an independent rotation, to adjust, fix, or remove at pleasure. A slip of glass, H, of about 1 inch in length, may be inserted in the body, having a gauge-mark drawn across it at a distance of $7\frac{8}{10}$ths inches from the bottom of the tube (inner surface), to ensure a given depth of the solution or syrup employed. The several parts being now duly centred, the apparatus is complete for ordinary observation; but for commercial or extended scientific research, a thermometer and hydrometer will be required, with tables of reference.



A syrup, prepared by boiling three or four ounces of loaf sugar in a corresponding quantity of water and filtered, while

hot, through blotting-paper, may be poured when cold into the tube on removal of the stopples, which are to be replaced; and when the upper piece E is rotated from left to right, a resplendent coloration is exhibited, following the *right-handed* prismatic series, in the order of violet, red, orange, yellow, green, blue, indigo, indicative of cane sugar. Then, for the development of the order of coloration indicative of grape or uncrystallizable sugar, proceed as follows:—empty the syrup from the tube into a phial, add two or three drachms of hydrochloric acid (one drachm of acid to nine drachms of syrup), and place aside for twelve hours, or thoughout the night. In the morning replace the acidified solution into the tube A, as before, and note the order of coloration, which, the cane, now being converted into grape-sugar, will, upon the rotation of the analyser or upper stopple E in the same direction as before (from left to right), present the reverse series of colours, or violet, indigo, blue, green, &c., &c. Of course, for practical quantitative or per-centage estimation, regard must be had to exact measures, to which we do not now refer.

The B eye-piece, selected as a measure for the calibre of the tube or body A, having been removed for the adaptation of the stopples, may at any time be replaced, and, instead of the Nicol's prism, be surmounted with a prism of uncut Iceland spar, or rather by a special double-image prism, for the magnified exhibition of the phenomena of simultaneous complementary coloration, the syrup being used as before.

Sufficient may have already been advanced to awaken interest and to induce investigation of the brilliant phenomena of saccharine polarization; and at the same time a clearer conception will have been obtained of the manipulation required for the purpose of subjecting diabetic urine to the polariscope, involving a process probably a little more complex than is usually considered of concentration, clarification, &c.

On the Structure *of the* Mouth *and* Pharynx *of the* Scorpion.

By Thomas Henry Huxley, F.R.S., Professor of Natural History, Government School of Mines.

Although the scorpion has been made the subject of repeated investigations by some of the best minute anatomists

of past and present times, it is a remarkable circumstance that no exact account of the structure of the commencement of its alimentary canal is to be met with, at least so far as my knowledge extends. Meckel ('Beiträge zur Vergleichenden Anatomie,' Band i, Heft 2, 1809), as might be expected from the fact that his dissections were performed without the aid of even a magnifier (page 106), takes no particular notice of the small and delicate parts in question. Treviranus ('Bau der Arachniden,' 1812) is equally silent as to this important portion of the economy of the scorpion; and even the accurate Johannes Müller, in the essay entitled "Beiträge zur Anatomie des Scorpions" (Meckel's 'Archiv.,' 1828), which threw so much new light upon the organization of this animal, although he saw more than either his predecessors or his successors have done, did not probe the matter to the bottom. In describing the alimentary canal, he merely says:—"The pharynx which arises in front of the brain, upon a particular, strongly excavated, portion of the skeleton, is much wider than the rest of the intestine, and resembles a vesicle. The œsophagus is very delicate where it proceeds from this vesicle, rises between the very stout nerves for the chelæ, above the brain (which lies behind the pharynx), and passes over the saddle-shaped upper excavation of the internal thoracic skeleton, whilst the spinal cord and the posterior cerebral nerves pass through the opening of the same skeleton."

Even the elaborate and beautifully illustrated memoir on the organization of *Scorpio occitanus*, published by M. Blanchard, a couple of years ago,* does not furnish the inquirer with either definite or accurate information on this point. At page 19, I find under the head of "*mouth*:"

"In the scorpion there exists only a single buccal piece properly so called; it is inserted in the median line above (*au-dessus*) the mouth, just below the cheliceræ (*antennes pinces*), and wedged in, so to speak, between the foot-jaws. It is a little flexible appendage, thinner towards its extremity, sensibly dilated laterally, convex above, and beset, chiefly at the end, with fine and silky hairs. This piece presents two apodemata (*apodemes d'insertion*), which diverge greatly from one another.

"One finds a certain difficulty in positively determining the nature of the single buccal appendage of the scorpion. It is impossible to regard it as the analogue of the labrum (*lèvre supérieure*) of insects. The labrum is one of those pieces which abort most completely in the arachnida. Besides, in all articulata, this labrum receives nerves which arise from the cerebral ganglia. It is different with the buccal appendage of the scorpion; its nerves arise from the anterior part of the subœsophageal ganglia, exactly

* The livraisons of M. Blanchard's work are unfortunately published without dates.

like those of the mandibles and maxillæ of Crustacea and Insects. It can thus only be compared to these pieces; but ought we to regard it as representing both the mandibles and the jaws, or only the mandibles, or the jaws, either one or the other being supposed to be aborted?"

With respect to both the main points contained in these paragraphs, however, M. Blanchard subsequently makes statements which seem difficult to harmonise with the conclusions enunciated.

Thus, at page 41, I find:

"The pharyngeal nerves are two pair. Those of the first take their origin from the anterior and median edge of the cerebrum, and almost immediately unite so as to form a single nerve, whose branches are distributed in the upper portion of the buccal appendage. It is evidently the analogue of the nerves of the labrum of insects."

And, again, at page 60:

"*Mouth and œsophagus.*—The buccal orifice appears under the form of a little transverse cleft, hidden under the cheliceræ *above* (*au-dessus*) the median appendage, which has already been described (p. 19); its edges are flexible, and are deprived of asperities. The œsophagus, which commences in a slightly funnel-shaped pharynx, is delicate, short, and widened posterity, so as to resemble what M. Leon Dufour calls the 'jabot' in insects. The œsophagus is held upon each side, towards its middle, by a fine muscular band directed backwards, and towards its point of union with the stomach by a similar band directed forwards. These muscles are attached to the sternal floor, formed, as is known, by the basilar pieces of the appendages. They serve to stretch the œsophagus either forwards or backwards, so as to facilitate deglutition.

"The walls of the œsophagus are thin and smooth internally, and present a few fine folds."

In the figures (*op. cit.*, pl. iv, figs. 1 and 6), which represent the anterior part of the alimentary canal, the œsophagus is represented as a straight, taper tube, ending in the mouth, without change of direction.

At page 32, M. Blanchard states, under the head of—

"*Muscles of the buccal appendage.*—We have indicated the two, long, diverging, apodemes of this piece (p. 19). Upon the base of each of them is inserted an elevator muscle, provided with two fixed attachments to the cephalo-thoracic shield in front of and external to the median eyes (pl. ii, fig. 4 *e e* and fig. 6 *a*). By its contraction, this muscle causes the buccal appendage to be elevated a little—a movement which takes place when the animal introduces food into its mouth. A transverse muscle is attached to the two apodemic plates (pl. ii, fig. 4 *f*); it is this muscle which, acting either on the one side or on the other, determines the slight lateral movements of the buccal appendage. It is to be observed, that this piece, solidly fixed between the foot-jaws, sensibly involves the latter during the execution of its slight movements."

The structure of the parts which I have observed in a large species of *Buthus* may be described as follows:

The "buccal appendage" of M. Blanchard is a vertically elongated, laterally compressed, cushion-like prominence, broad and rounded above, where it is marked by a slight median ridge, slightly concave from above downwards in front, and narrowed below (Pl. XII, figs. 1, 2, 3 *b*). Its anterior and lateral surfaces are covered with fine, short hairs, which form a projecting pencil at its anterior inferior angle. There is no aperture whatsoever above this body, between the cheliceræ; but, below and behind it, the aperture of the mouth, large enough to admit the head of a fine needle, can be very easily found. I entertain no doubt, therefore, that this "buccal appendage" is a true labrum, and, indeed, in all essential respects, it is exactly like that part in the *crustacea*.

The convex lower surface of the labrum bounds the mouth in front, while behind, it is limited by a transverse thickening of the chitinous integument, which appears to represent the sternum of the mandibular somite (fig. 4 *o*). The mouth opens into a very curious pharynx, formed by a delicate outer investment, and a strong inner chitinous lining. Viewed laterally, this organ (*c*) has the shape of a pear, its broad end being uppermost, and its long axis directed obliquely upwards and backwards, in such a manner, that the broad upper end lies in the middle, between the prongs of the fork-like apodeme, which M. Blanchard has described. Viewed from above or below, however, the pharynx appears to be very narrow, indeed, almost linear, in consequence of its very peculiar form, which is displayed in the section, taken transversely to the longitudinal axis and perpendicularly to the vertical plane represented in fig. 5. The cavity of the sac is here seen to be triradiate, while its walls are very closely approximated, so as to leave but a slight interspace. The narrow band which joins the two lateral walls below and behind is slightly excavated, so as to present a convexity towards the cavity of the pharynx. The two shorter rays of the sac are turned upwards and outwards; the third longer ray is directed vertically downwards. The œsophagus, an exceedingly delicate and narrow tube, comes off from the posterior wall of the vertical ray or crus of the pharynx, just above the mouth; and, widening, passes backwards and upwards, into the dilatation which receives the ducts of the so-called salivary glands (*e*). Just above the aperture is a rounded projection (fig. 6 *p*), which I suspect may act as a sort of valve, when the sides of the pharynx are divaricated, by more or less completely occluding the œsophageal

aperture. The inner surface of the chitinous lining of the pharynx is more or less rugose; and, towards the œsophageal aperture, presents a number of very minute spines (fig. 6).

The transverse muscular fibres (fig. 2 *n*), rightly said by M. Blanchard to arise from the forks of the apodeme (*m*), are inserted into the side walls of the pharyngeal sac, which is so narrow from side to side, as readily to escape notice, without dissection. The termination of the aorta appeared to me to pass between the two superior crura of the sac.

The large vertical muscles (fig. 1 *q*) are, as M. Blanchard states, inserted into the base of the apodeme; and, besides these, the labrum is traversed by strong transverse and longitudinal muscles.

The mode of action of this curious apparatus appears to be readily intelligible. Scorpions, as is well known, suck the juices of their prey, and the pharyngeal sac seems to be well calculated to perform the part of a kind of syringe. For, suppose the prey to be held between the labrum above, the bases of the great mandibles at the sides, and the processes furnished by the maxillary limbs below, and that the minute oral aperture is applied to a wound. Then, if the transverse muscles (*n*) contract, the sides of the pharynx will be drawn apart, and a partial vacuum, or at least a tendency to the formation of one, will be created. If, by the same action, the projection (*p*) is brought down over the œsophageal aperture, regurgitation from the œsophagus will be prevented; but, in any case, as the oral aperture is larger than the œsophageal, it will be easier for the sac to be filled through the mouth. The sac being full, if the labrum is depressed so as to close the oral aperture, and the transverse muscles are relaxed, the elasticity of the walls of the pharynx will tend to reduce its cavity to its primitive dimensions, and hence to drive the ingested liquid into the œsophagus. Successive repetitions of the action would gradually pump the juices of the prey into the alimentary canal of its captor.

TRANSLATIONS.

On the ORIGIN *of* FERMENTS. *New experiments relative to so-termed Spontaneous Generation.* By M. L. PASTEUR.

('Comptes Rendus,' May 7, 1860, p. 849.)

AMONG the questions arising during the researches which I have undertaken on the subject of fermentations properly so termed, there is none more worthy of attention than that which relates to the origin of "*ferments.*" Whence proceed these mysterious agents, so feeble in appearance, and yet in reality so powerful; which in the minutest quantity, measured by weight, and with insignificant external chemical characters, possess such extraordinary energy? It is in an attempt to solve this problem that I have been led to the study of the so-termed spontaneous generation.

In the communication which I had the honour of submitting to the Academy on the 6th of February last, I mentioned only a single fluid appropriate for the development of Infusoria and Mucedinea, although I gave a general method applicable to all liquids.

On that occasion I showed, in a manner that has been contested only in appearance—First, that the solid particles conveyed in the atmospheric air were the origin of all the vegetable and animal productions peculiar to the fluid in question. Secondly, that these particles, examined under the microscope, are amorphous, dusty atoms, constantly associated with certain corpuscles, whose form, volume, and structure show that they are organized after the manner of the ova of Infusoria or of the spores of the Mucedinea.

I am, at present, in a condition to extend the assertions contained in the communication of the 6th February to two substances, still more alterable than the sugared water mixed with albuminous matters which had been more particularly the subject of my former experiments. I now speak of

"milk" and "urine." The details of the results derived from these two fluids will show, as I hope, the kind of future in store for this department of study.

I introduce about 100 cubic centimeters of recent urine into a flask capable of containing 250 cubic centimeters. The drawn-out neck of the flask communicates with a platinum tube, heated to redness. The liquid is made to boil for two or three minutes, and then allowed to cool. When refilled with air, which has been subjected to a red heat, the flask is hermetically closed.

The flask, under these conditions, may remain for an indefinite time in a stove, at a temperature of 30° C., without its undergoing any alteration. After the lapse of a month or six weeks, I cause a small quantity of amianthus charged with the atmospheric dust to fall into the flask, the mode in which this is effected being precisely that described in the 'Comptes Rendus' of the 6th of February. The neck of the flask being then again hermetically closed, the apparatus is replaced in the stove.

In order to be sure that the manipulation to which the flask is submitted, for the introduction of the atmospheric dust, does not itself in any way affect the result of the experiment, I prepare a second flask similar to the other; only that, instead of allowing amianthus charged with atmospheric dust to fall into it, I substitute the same amianthus previously calcined for some moments before its introduction into the flask.

The following are the constant results of the experiments so made.

The fluid in the flask which has received the amianthus deprived of the atmospheric dust remains unaltered at the temperature of 30° C., whatever may be the duration of its exposure to this heat, which is so favorable to the putrefaction of urine. On the contrary, at the end of six hours, the urine which has received the atmospheric dust, presents organized products—Mucedinea or Infusoria. Among the latter I have noticed chiefly *Bacteria*, very minute *Vibriones*, and *Monads*, in fact, the same Infusoria that I have found in the same urine exposed to the contact of the atmospheric air at a temperature of 30° C. During the following days will be witnessed an abundant deposition of crystals of ammoniaco-magnesian phosphates and of the alkaline lithates. The urine becomes more and more ammoniacal. Its urea disappears under the influence of the true ferment of the urine, a ferment which I have proved to be organized, and whose germ could only have been introduced in the atmo-

spheric dust, as well as that of the Infusoria or of the Mucedinea.

Milk exhibits still more interesting properties. I have said that, before filling the flask with air which has been subjected to a red heat, and hermetically closing it, I caused the urine to boil for two or three minutes. This duration of the ebullition is sufficient, and everything leads me to believe that even less careful precautions will suffice to deprive of all viability the germs which may have fallen into the urine subsequent to its emission.

This being granted, let us repeat, without any change, the operation above described—now, however, not upon urine, but upon fresh milk; that is to say, after this fluid has been boiled for two or three minutes, and the flask has been refilled with air heated to redness, let us keep it closed at a temperature of 30°.

After a variable lapse of time—generally of three to ten days—the milk in all the flasks thus prepared will be found coagulated. Under the prevalent views respecting the phenomenon of the coagulation of milk, there is nothing in this circumstance to excite surprise. When milk, it is said, is exposed to contact with the oxygen of the air, the albuminous element is altered and acts as a ferment. This ferment reacts upon the sugar of the milk, and transforms it into lactic acid, which then precipitates the casein. This is the cause of the coagulation. In reality, however, things are quite otherwise. For if one of these flasks in which the milk is coagulated be opened, it is obvious, on the one hand, that the milk is *as alkaline as fresh milk;* and on the other —a circumstance tending to encourage the belief in spontaneous generation—that the milk is filled with Infusoria, most frequently with Vibrios, as much as $\frac{1}{10}$th millimeter in length. As yet I have not met with any vegetable production under these circumstances.

From these facts we must admit—First, that the phenomenon of the coagulation of milk, as I hope shortly to demonstrate more clearly, is a phenomenon upon which we have had but very imperfect notions. Second, that *Vibrios* may arise in a liquid of the nature of milk which has undergone ebullition for several minutes at a temperature of 100° C., although this is not the case with respect to urine, nor to a mixture of sugar, water, and albumen. Is it the case, then, that under particular conditions we may have spontaneous generation? We shall soon see how far this conclusion would be erroneous. Let the milk be boiled, not for two, but for three, four, or five minutes, and it will be found that the

number of flasks in which it coagulates from the presence of Infusoria diminishes progressively in proportion to the longer duration of the ebullition. And lastly, if the ebullition be carried on at a temperature of 110 to 112 degrees, under the pressure of 1½ atmosphere, the milk will never afford any Infusoria. Consequently, as they do arise under the conditions existing in the former experiments, this is evidently due to the circumstance that the fecundity of the germs of the *Vibrios* is not entirely destroyed, *even in water* at a temperature of 100°, kept up for some minutes, and that it is more affected by a longer ebullition at that temperature, and wholly abolished at the temperature of 110° to 112° C.

But what is to be said concerning the phenomenon of the coagulation under those special conditions of ebullition, in which the milk in contact with calcined air never affords any Infusoria? One remarkable fact is, that the *milk does not coagulate*. It remains alkaline, and preserves, I would venture to say, entirely all the properties of fresh milk. Then if, into this milk, thus retaining its integrity, the atmospheric dusty particles are introduced, it changes and coagulates, and the microscope shows the existence in it of divers animal and vegetable productions.

It would be very interesting to ascertain whether the fluids belonging to the animal economy, such as milk and urine, contain normally or accidentally, previously to all contact with the common air, the germs of organized productions. This is a question which I hope to resolve in a subsequent communication.

The generally admitted theory of ferments, and that which of late years had received fresh support from the writings or the labours of various chemists, consequently appears to me more and more incongruous with experiment. The "ferment" is not a dead substance, without determinate specific properties. It is a being, whose germ is derived from the air. It is not an albuminous substance, altered by oxygen. The presence of albuminous matters is an indispensable condition of all fermentation, because the "ferment" depends upon them for its life. They are indispensable in the light of an aliment to the ferment. The contact of the atmospheric air is, primarily, equally an indispensable condition of fermentation, but it is so in virtue of its being a vehicle of the germs of the "ferments."

What is the true nature of these germs? Do they not require oxygen, in order to pass from the state of germs to that of adult ferments, such as are met with in the products

undergoing fermentation? I have not yet arrived at any fixed conclusion with respect to these grave questions. I am endeavouring to pursue the inquiry with all the attention it merits; but the really capital difficulty of these studies consists in the isolated, individual production of the various ferments. I may assert that there are a great many distinct, organized ferments, which excite chemical transformations, varying according to the nature and organization of the ferment. But in most cases the nutriment suitable to some allows of the development of others of them, whence arise the most complicated and the most variable phenomena. If we could only isolate one of these ferments, in order to develop it by itself, the chemical transformation corresponding to it would take place with remarkable precision and simplicity.

I shall, in a short time, give a new instance of this, in describing the organized ferment proper to the fermentation termed "viscous."

Researches on the Corpuscles *introduced by the* Atmosphere *into the* Respiratory Organs *of* Animals. By M. F. Pouchet.

('Comptes Rendus,' 1860, p. 1121.)

I have thought for a long time that the study of the bodies conveyed by the air into the respiratory passages of animals would offer interesting physiological results, and throw considerable light upon the subject of atmospheric Micrography. Nor have I been deceived in this. In fact, in almost every class of animals, the examination of the respiratory apparatus clearly reveals the various modifications of the medium inhabited by them. But it seemed to me that the most important notions on this subject would be presented in those animals in which the air penetrates the most deeply into the organism. Birds, consequently, have become the objects of particular attention, seeing that in them the air, after traversing the lungs, pervades not only the different cavities of the trunk, but reaches also the interior of the osseous system. In these animals I have devoted particular attention to the examination of the bones which contain most air, and chiefly to the *humerus*. And as in

these situations the corpuscles, once introduced, escape only with great difficulty, owing to the immobility of the walls and the irregularities of their anfractuosities, we there find ample vestiges of all the matters conveyed by the air into the respiratory organs.

The examination of animals living in the midst of towns, and in the interior of our dwellings, will excite surprise by the enormous quantity of starch-grains contained in their respiratory organs. In birds, corpuscles of this nature will be discovered in great abundance, even in the interior of the bones, and together with them will be observed, in profusion, particles of sooty matter and filaments derived from the various fabrics of which our clothes are made. But the further the creature lives from towns, the more remote and wild its habitation, the more rare also become all these corpuscles in the inspired air. Under these circumstances, scarcely any traces of the sort can be observed. Frequently, even not a single particle of the kind in question will be observed in animals or birds living altogether in the midst of forests; in these animals, on the other hand, the whole respiratory apparatus is filled with abundant débris of plants,—epidermis, chlorophyll, &c.

The amylaceous particles disseminated either in the atmosphere or in the interior of animals present two conditions—they are either in the normal state or cooked. In the majority of cases the starch is found in the former condition; but, nevertheless, we frequently meet, in the atmosphere, and in all the cavities of animals into which the air enters, with starch-grains, either simply swelled or entirely burst by the action of heat. The latter certainly proceed only from minute particles of bread carried about by the movements of the atmosphere. This panified starch is readily recognised by its enormous size and ruptured condition, and by the action of iodine, which does not produce in it the same bright colour as it does in ordinary starch-grains.

The birds which inhabit the interior or live in the close vicinity of towns do not obtain this abundance of amylaceous particles simply from the air they inspire; they derive, besides this source, an abundant supply from the foliage of the trees amidst which they pass part of their lives. In fact, on examining the surface of the leaves of trees in the neighbourhood of cities, when they have not been washed for some days by rain, abundance of specimens of every sort of corpuscles carried in the atmosphere will be found on them, and, universally, a considerable quantity of starch-grains, together with sooty and siliceous particles. On a single leaf

of a Horse-chestnut, growing in the garden of the Ecole de Médecine at Rouen, I have counted about thirty grains of wheat-starch, either in the natural or panified condition.

The search for atmospheric corpuscles in the respiratory passages is easily made. It consists simply in the passing of a stream of water through these passages, and the collection and examination of the fluid. For this purpose I inject the trachea, by means of a syringe, and when the lungs are distended with water, make incisions into them, and carefully collect all the fluid that escapes, repeating the injection several times.

In birds I inject the trachea, and when the water has traversed the lungs and filled all the air-cavities of the body, I open the thoracic cavity, and collect the liquid which escapes in a jet. In all the experiments the fluid is received in conical vessels, with a narrow bottom, and when sufficient time has elapsed to allow all the corpuscles to subside these are removed by means of a very slender pipette, and submitted to microscopic examination. The atmospheric corpuscles may be collected from the hollow bones by the same mode of procedure. To effect this, I insert the tube of a syringe into the orifice, by which the air penetrates into the cavity, and then make a section of the bone at the opposite end. The water injected, at first gently, and afterwards with great force, in order to carry along with it the smallest corpuscles, is received in champagne-glasses and examined. Studied in this way, the respiratory organs afford a faithful idea of the life of the animals. Not only does the examination reveal to us what sites of habitation the animals prefer, and their kind of food, but even, when they are domesticated, the profession followed by their owners.

I have found in the air-passages of man the same atmospheric corpuscles as are with met in animals. In the bodies of two persons who died in one of our hospitals, a man and a woman, whose lungs I injected, I found a large quantity of wheat-starch, either normal or panified; particles of silex and of glass; fragments of dye-wood, of a beautiful, red colour; fragments of dress and, lastly, a larva of a microscopic arachnidan, still living.

It was rational to conclude that, at certain times, the expectoration should contain corpuscles similar to those I have described in the lungs. And this is actually the case; I have here met with normal and panified starch-grains, particles of soot, the débris of plants, filaments of wool or cotton of various colours, particles of silex, &c.

A fowl, brought up in a paved court at Rouen, afforded in its respiratory sacculi an enormous quantity of wheat-starch, normal and panified. Besides which they contained numerous filaments of cotton and of linen, and an abundance of sooty particles; there were but a very few siliceous grains, a circumstance probably owing to the habitation in which the bird had existed. The humerus of this bird also contained much starch, particles of soot, a considerable number of cotton and linen filaments, and even some grains of potato-starch and of glass.

Thinking that in animals living in localities where starchy matters formed an object of trade, the abundance of amylaceous particles would be still greater, I procured two young chickens which had been kept for two months by a baker. My surmise was not unfounded. The whole of the respiratory organs in these chickens, notwithstanding their youth, contained an amount of starch surpassing that which I had found in the fowl.

A pigeon taken from a dove-cot in the middle of the town presented, in its respiratory passages, besides particles of silex and soot, the débris of stuff of various colours and a few grains of potato-starch, together with a considerable amount of wheat-starch of all sizes, and, above all, an enormous quantity of lentil-starch. Even the *humeri* contained so much of the latter, that from eight to ten grains were found in every case. I was unable to explain the presence of such an abundance of lentil-starch in a bird which always swallows seed without bruising it. But I very soon discovered the source on examining the floor of the dove-cot. This was completely covered with the dung of the pigeons, containing an enormous quantity of this sort of starch, which had passed through the intestines unaltered. In flying about in their dwelling the birds diffused this in the air, and it thus gained an entrance into their respiratory organs.

The examination of a bird which is ordinarily kept only in wealthy establishments affords another proof of what has been said. In fact, the numerous vestiges of magnificent stuffs exhibited in its respiratory organs manifestly recalled the luxurious dresses or works of those amongst whom it had it had lived. This bird was a peacock. Unfortunately I had at my disposal only its *humeri*; but having injected them, I was really struck with the abundance of, and the splendid colours presented by, all the fragments of stuffs contained in these bones. I found, besides a considerable quantity of wheat-starch, numerous filaments of wool and of silk of the most magnificent blue, of a beautiful rose, and bright green.

The lungs of a Mouse also afforded starch, silex, and soot, but in far less quantity and in far smaller fragments than in the birds.

But if our attention be directed to wild birds, residing at a distance from cities, we observe a totally different thing.

A Gray Falcon (*Falco cineraceus*, Mont.), killed in a large forest two leagues from any habitation, did not afford the least trace of starch, either in its air-passages or within the bones. There were met with only a few particles of soot and silex; and not a single filament of any kind of tissue was recognised. But, on the contrary, all the air-passages were filled with an abundance of the detritus of plants and débris of insects.

In another wild bird (*Picus viridis*, Linn.) I found in the air-passages only an insignificant quantity of starch, and very little soot and silex.

In some frogs taken in the basins of the Jardin des Plantes at Rouen, which is situated close to numerous factories and in a populous quarter, the lungs have always afforded a notable quantity of starch, an abundance of particles of charcoal and coal-soot, together with numerous fragments of silex and vegetable débris. Besides these, filaments of cotton, raw or manufactured, were extremely abundant. The respiratory organs of these animals also contained *Naviculæ*, diatoms, papilionaceous scales, the stems of mucedinous fungi, and fragments of Confervæ.

If, again, we explore the respiratory passages of some animals which, although living in a state of liberty, are in the habit of frequenting our dwellings, we find in them evident vestiges of their double existence, wild and domestic.

A Jackdaw afforded a striking instance of this. Its respiratory organs contained a very considerable quantity of wheat-starch; and what was very remarkable, an enormous number of sooty particles—a circumstance which is accounted for by the almost habitual abode of this bird on the lofty buildings of towns. There were found also, in its air-sacs, numerous filaments of cotton and abundant débris of plants.

In all my observations, which, without exaggeration, might be counted by hundreds, I have never met with either a *single spore* or a single ovum of a microzoon, nor with any encysted animalcule. Moreover, if in all these minute researches I have always been able to detect starch-grains wherever they existed, is it possible that the atmospheric spores and ova alone should have escaped detection? The ova of certain *Paramæcia*, being ·0420 mm. in diameter, and consequently surpassing considerably in bulk the largest grains

of wheat-starch, whose diameter does not exceed ·0336 mm., if they really existed in the atmosphere in sufficient quantity to explain the generation of Infusoria, whose apparition astonishes and stupifies us, should have been immediately discovered in the same situations, and far more easily even, than the starch-grains, seeing that they ought to exist in much greater numbers. To a negation of this kind, in the actual state of science, but one answer is possible—*show these ova.*

On Chitine. By M. A. Baur.

In 'Reichert's Archiv' for 1860,' part 1, M. A. Baur has published an interesting memoir on the chitinous tendons of Articulata, and their relation to the change of skin. The simplest and oldest view of these structures regarded them as being nothing more than inward prolongations of the outer skeleton, resembling true tendons, but not as corresponding to those of the Vertebrata, which consist of connective tissue. Leydig, on the other hand, considers that these tissues do correspond to one another, and that, while the tendons of Vertebrata often become bony, those of Articulata tend to change themselves into chitine.

If, indeed, as has been supposed to be the case, the chitine and connective tissue of the tendons are in continuous connexion, and pass gradually into one another, then we should be forced to consider them as nearly allied, and that chitine is, in fact, a modification of connective tissue.

This view of the question is maintained by Leydig, but on the other hand is opposed by Häckel and Kölliker, according to whom the chitine of the Articulata is a laminated secretion of the epithelial cellular layer. The external chitine is known to be continuous with the intima of the intestinal canal, and this latter is admitted by Leydig to be a secretion of the epithelium. The theory supported by Häckel and Kölliker has, therefore, this advantage, that it does not disunite structures which are histologically identical, but considers the whole chitine skeleton of the Articulata from one point of view. If, however, it is correct, then it becomes a general characteristic of chitine that it always forms the boundary of free surfaces, or the lining of those that are turned inwards.

To this law, however, chitinous tendons must, according to the ordinary opinion, form an exception, since in them the chitine forms a solid substance, and is continuous with connective tissue. An epithelial secretion and connective tissue cannot, however, possibly be continuous with one another, since they must, at least, be separated by the epithelial layer to which the former owes its existence. If, therefore, chitine *is* the secretion of an epithelial layer, the tendons may pass into it, or may pass into the connective tissue, but assuredly not into both. In the first case the apparent chitine of the tendon is really a process of the outer skeleton; in the latter it is true connective tissue. Hackel endeavours to prove the latter of these two alternatives, considering that the chitine of chitinous tendons possesses neither the fine canals nor the cell-impressions which are found in true chitine. According to Leydig, on the contrary, chitinous tendons prove that ordinary chitine is, in fact, a modification of connective tissue.

The controversy may be reduced to the following questions:—Are the chitinous tendons continuous with the outer skeleton only, with the connective tissue only, or do they pass insensibly into both? In the first case the tendon is a continuation of the outer integument, in the second it is composed of modified connective, and in the third case the chitinous outer skin must itself be regarded as an abnormal form of connective tissue.

In the ordinary state of the tissues these problems are difficult of solution, but they become comparatively easy if we examine an animal at the time of moulting. It is well known that the tendons are cast with the skin. If one takes a crayfish which is just about to moult, we shall find the soft new skin lying under the hard old one: if we now isolate the mandibular muscle, so that on the one side it is attached to the back of the cephalothorax, while on the other its tendon is united to the mandible; and if we remove from the latter its old chitinous covering, which can generally be effected without much difficulty, the chitinous tendon will come away also. The muscle does not, however, thereby lose its attachment to the tendon, but as under the old, hard skin of the mandible, a new and soft one is formed, so also, instead of the old tendon, we find a new tendon, which is attached to the new mandible. The new tendon resembles the old one in form and sculpture, but it differs from it in consistence; and also in this, that, while the old tendon is apparently solid, the new one is distinctly tubular—and, in fact, the old tendon lies in the

hollow of the new one. The new tendon, however, remains hollow only for a short time; and when the old one has been pulled out, its walls gradually close in upon one another, and it soon puts on the appearance of a solid body.

The integuments of the crayfish consist, as Häckel has correctly shown, of an outer layer of chitine and an inner skin composed of connective tissue. These two, however, are never continuous with one another, but are always separated by a number of cells, or rather, perhaps, of nuclei, which form a single layer, and are specially evident at the time of moulting. The new layer of chitine is formed between the old one and this layer of cells, and it is therefore evidently produced by them. The connective tissue, which is of variable thickness, has therefore no chitinogenous function, and serves only as a substratum for the true chitinogenous layer. At the time of moulting another layer, that is to say the new chitine, is added to the three layers always present; this is equally true for the tendon as for the mandible, but with this difference, that the latter being a projection, and the former an inversion of the skin, the order of sequence of the layers is reversed. This structure is not confined to the main stem of the tendon, but is repeated in its branches; each one of these presents the same arrangement, but the outer connective tissue increases in size at the expense of the chitine, which finally disappears where the muscle commences, so that the sheath of the muscle is formed by the expansion of the layer of connective tissue only.

Häckel denies that the pore-canals, which are so characteristic of true chitine, exist in chitinous tendons. Certainly in a longitudinal section no trace of them can be perceived; but if the tendon is cut transversely, besides the laminar structure a radial shading may be perceived, like that which is seen in sections made at other parts of the chitine skeleton, and which is referred to the presence of pores. Here, however, evidently no pores are present; and without wishing to deny that they do occur in other parts, it may at least be asked whether the appearance presented has not been, in this respect, misunderstood. The cell-impressions are also absent in the chitine of tendons, as indeed in some other parts of the skeleton, but certainly these two differences are not sufficient to prove that the tissue in question is not true chitine.

The principal conclusions to which M. Baur arrives are that the so-called chitine tendons are inwardly projecting, originally tubular, subsequently solid, and more or less branched

portions of the general integument. 2dly. That the tendon is composed of the same layers as the skin, but with an inverted, concentric arrangement. Thus the external chitine of the outer skin is continuous with the inner chitine skeleton of the tendon, the lower connective-tissue layer of the skin with the connective-tissue sheath of the tendon, and this only is immediately connected with the connective tissue of the muscle. 3dly. The chitinous skeleton of the tendon is cast with the skin at every moult; and this is true, not only of the main stem, but also of its finest branchlets. 4thly. Continuity between chitine and connective tissue never occurs but in the finest branches of the tendons, as everywhere else they are separated by a layer which secretes the chitine. 5thly. The chitine of the tendons does not in reality differ from that of the general integument; the apparently fibrous condition, and the longitudinal striation, and the capability of being split, all arise from the folding of the homogeneous lamellæ, which takes place after the removal of the old tendon, and when the young chitine has already attained a certain degree of hardness.

The chitine of the tendons forms therefore no exception to the general rule, that this structure occurs only as a covering of free surfaces; and the chitinous tendons can no longer be relied on as a proof of the connexion which has been supposed to exist between chitine and connective tissue. Since, however, the chitine of tendons possesses no pores, nor any cell-like impressions, these conditions can no longer be regarded as necessary to true chitine, and the characteristics of chitine are therefore reduced to these, that it bounds surfaces, consists of a variable number of homogeneous lamellæ, possesses a certain power of resisting chemical agents, and is constantly accompanied by a soft and thin layer, consisting of a simple series of nuclei connected together by a molecular substance. Taking it therefore for proved that chitine is not to be regarded as a form of connective tissue, M. Baur concludes his memoir by considering in what manner it is produced by the chitinogenous layer. This might be effected in two ways; either this layer might be changed into chitine, in which case it must be regarded as an immature form of chitine; or the chitine might be directly produced by the chitinogenous layer. In the first of these cases, however, we ought to find layers in every intermediate state between chitinogenous tissue and true chitine, which is by no means the case. On the contrary, even the youngest lamellæ are true chitine, and show no resemblance to the chitinogenous layer.

It would seem therefore that Kölliker and Häckel are right in considering that chitine is secreted by a subjacent chitinogenous tissue; though, as this latter cannot be broken up into separate cells, it may be doubted whether it can be correctly termed a layer of epithelial cells.

NOTES AND CORRESPONDENCE.

The Nose-piece Finder.—My observations on the nose-piece finder (inserted in your last number) have drawn me into a little controversy with a scientific gentleman of great microscopic experience.*

He says, "I have just read your remarks on the application of the double nose-piece as a 'finder.' It is, of course, as good a one as we can have, *provided the object is large enough, or sufficiently opaque, to be seen by the* 1½ *objective* · but when it is with great difficulty seen with the 1-inch, the 'nose-piece, as a finder, is useless,'" &c.

He then instances several of the smallest examples of Diatomaceæ (*e. g. Eunotia Bactriana*), which are so exceedingly minute and (when prepared in balsam) so exquisitely hyaline, that it is to be doubted if they can be discriminated with so low a power as 1½-inch, &c.

These objections have set me upon a very careful course of examination and trial; for nothing could be more unpleasant to me than to find that I had misled any one by an erroneous statement. But I am happy to say that the result has been rather a corroboration of my former assertions, with only this *modification*, that more ought to have been said on the subject of eye-pieces; for a 1½-inch objective acting along with eye-piece A is very different from the same with eye-piece D, &c. Then, again, eyesights differ in quality; some individuals being able to see a smaller speck with a 2-inch objective than others can with 1-inch, and so on.

With 1½-inch objective and eye-piece A I can very distinctly see the spot in the centre of *P. angulatum*. With eye-piece D an object not a fourth part that size might be seen so as to be perfectly recognised.

The same combination will also distinctly show the reticulations on a scale of *Morpho Menelaus*.

* Mr. F. Kitton, of Norwich.

Moreover, some persons do not use a lower power than 1-inch; and, if so, and that lens be employed as the "finder" with eye-piece D, I do not believe there is any *organic* object that cannot be distinctly discerned thereby; as that combination will clearly show a particle sufficiently small to *pass through* the mesh in the above-mentioned scale (taken from the under side of the wing), which meshes I find, by micrometrical measurement, to average about $\frac{1}{300}$th of an inch in length and $\frac{1}{10,000}$th in breadth.*

This, as formerly said, I will undertake to *prove* to any one who may think it worth while to come here for the purpose.

So that, to shorten the matter as much as possible, the entire question may be resolved into the following heads:

1st. The double nose-piece is amply sufficient for the immediate finding, with the highest powers, of all the *generality* of objects, even those which are totally invisible to the unassisted eye.

2d. Those objects that are *difficult* of detection with so low a power as 1½-inch are (comparatively) *very* limited in number; and that any of them are *impracticable* (with eye-piece D) I have great doubt.

3d. Eyesight differs greatly in quality in different people; so that microscopists must be cautious in pronouncing "that will never do," &c., when the whole truth is, that will never do for *me*.

For my own part I am more and more pleased with the "nose-piece finder," and am using it continually, to my very great comfort; but for the benefit of those who are *not* satisfied with it, and are *especially* bent on screwing their unfortunate optic nerves to hunt out those *excruciatingly* small objects which they cannot *find* with inch objective and eye-piece D, it may be well to state that of all the finders hitherto devised on the graduated-plate system, Mr. Kitton gives the preference to that of Mr. Maltwood, described in your journal for April, 1858.

In conclusion, my remarks have been given upon the principle of "*valeat quantum valere potest*," and my readers will now, of course, do as they please in the matter; but I cannot refrain from giving them a well-meant caution, that the less they strain their "visual optics" over these almost

* These measurements were made by means of the good old stage-micrometer, with which Mr. Powell used to supply his instruments many years ago. I think highly of it, and do not know why it is now so rarely made. One turn of the wheel is the $\frac{1}{100}$th of an inch; and the wheel being divided into 100 degrees, one degree equals $\frac{1}{10000}$th.

infinitesimally minute "marvels of the microscope" the better it will be for them if they are spared to enter those years of senility to which, I regret to say, I am rapidly approaching; or, in vulgar speech, you'll smart for it if you live to be old fellows.—HENRY U. JANSON, Pennsylvania Park, Exeter.

Composition of a Blue Transparent Injecting Fluid for Anatomical and Pathological Preparations.—Not having been very fortunate in preserving microscopic injections of tissues made with the very beautiful blue fluid recommended for the purpose by Dr. Lionel Beale,* I was induced, in conjunction with Professor Barker, of Dublin, to endeavour to discover a blue fluid of a less fugitive disposition than the one alluded to.

Having performed many experiments with different injecting fluids, we found that tissues injected with a colour of the same chemical composition as Turnbull's blue, are not so liable to fade as those injected with the Prussian blue.

When ferridcyanide of potassium is added to a salt of the protoxide of iron, a beautiful blue precipitate is the result. It is somewhat brighter in tint than Prussian blue, and its colour is unexceptionable.

Having been very successful in preserving preparations made with this blue, we thought we should not lose any time in mentioning the proportions we found to answer best for making a free-running injection.

Composition of the blue fluid:

Purified sulphate of iron . . .	10	grs.
Ferridcyanide of potassium . . .	32	„
Glycerine (Price's)	1	oz.
Wood naphtha or pyro-acetic spirit .	1½	drachm.
Spirits of wine	1	oz.
Water	4	„

Dissolve the sulphate of iron in one ounce of the water, and the ferridcyanide of potassium in another ounce, then gradually mix the two solutions in a large bottle, shaking well during the mixture. Next add the naphtha to the spirit, the glycerine, and the remainder of the water. Finally, add this mixture to the Turnbull's blue, and again shake well while they are mixing.

Those familiar with Dr. Beale's fluid will perceive that the difference between it and the one we recommend only con-

* 'How to Work with the Microscope,' p. 78.

sists in the materials for making the blue, the other ingredients are similar to his, and we have found them to form an admirable combination for suspending the insoluble and minutely divided precipitate.

In order to mount injections made with the Turnbull's blue, the following plan is recommended:

If the injected sections will bear it, they should be well and repeatedly washed with cold water. Portions of the kidney, for instance, we have left in water for three or four days, changing the latter frequently during the period. When thoroughly washed, they should be placed, for a week or more, in glycerine, acidified with dilute muriatic acid, and, lastly, mounted in cells with some of the following solution.

Composition of the preservative fluid for the blue injections:

Glycerine (Price's)	5 drachms.
Creasote and naphtha fluid (Beale's*) .	½ drachm.
Dilute muriatic acid	a trace.

Mix.

—Ben. Wills Richardson, F.R.C.S.I., Dublin.

On Extravasations of Blood, and the production of Aneurisms caused by Parasites.—An interesting paper on this subject, chiefly with reference to appearances often observed in the frog, is published (Reichert and Du Bois Reymond's 'Archiv' for 1860, p. 195) by Louis Waldenburg. The conclusions at which the author arrives are the following:

1. The hæmatode cysts of the frog contain altered blood, due to extravasations produced by nematode worms which have migrated into the blood-vessels.

2. The horny filaments met with in the mesentery and coats of the intestine in frogs are bodies of foreign origin, which have gained admission from without into the circulating system of the animal. They are lodged in true aneurismal swellings of the blood-vessels caused by their presence, are surrounded by a *thrombus*, and are at the same time the cause of the numerous minute cysts observed in their vicinity, and which are also to be regarded as encysted aneurisms.

3. The pigment-follicles attached to the vessels in the spleen, liver, and kidney of fish, and which contain Psorospermia, are also aneurisms caused by animals from which the Psorospermia are derived, and which animals are found in the vessels.

* 'How to Work with the Microscope,' p. 36.

On a new Reagent for the Exhibition of the Axis-Cylinders in Nerves.—I believe the fact I am about to state worth publication, as I am not acquainted with any other reagent which, in perfectly fresh nerves, immediately renders the axis-cylinder so distinctly visible. My experiment consists in first splitting open the neurilemma with the needle, and then, without the addition of any fluid, in gently spreading out the fibres upon the glass slide. I then immediately place a drop of *collodion* on the preparation, and cover it with the thin glass. Immediately, and in all the fibres, the most beautifully defined axis-cylinders are rendered apparent; the medullary matter assuming a fine, granular aspect.*—Dr. Edward Pflüger.

High Powers.—In a foot-note to p. 145 of the "Proceedings of the Microscopical Society," published in No. XXXI of the Journal, it is stated that Mr. Wenham has constructed an object-glass of $\frac{1}{50}$th of an inch focal length.

This announcement was, doubtless, hailed with much satisfaction by all who, like myself, believed that the microscope had not yet reached the useful limit of amplifying power, and microscopists are much indebted to Mr. Wenham for his continued exertions in the improvement of the instrument.

It is not, however, with a view to flatter Mr. Wenham that I now write, but to remind that gentleman that it will depend mainly, if not entirely, upon the discoveries he may be able to announce, whether the use of these high powers shall be limited to himself or become available to all who may be able and willing to incur the expense. I have been informed that our best makers declare *there is nothing to be gained by the use of higher powers than those they now make*, and yet Beck and Co. supply two, Ross three, and Powell and Lealand four additional eye-pieces to increase the power of the object-glass! although they know that, even with their excellent workmanship, power is only gained in this way at the expense of light and (too often) of definition. This seems in contradiction to their declaration. If nothing be really gained by increase of power in the object-glass, why give us anything beyond the first or, at most, second eye-piece? The truth, however, I believe, is this. Eye-pieces are easily made, and their small price places them within the reach of all; but to increase the power of the object-glass

* Reichert and Du Bois Reymond's 'Archiv u. d. Anat. Physiol.,' 1859, p. 132.

would be attended with difficulties, perhaps, at least for a time; and if they were sold at prices proportionate to those now charged for the $\frac{1}{12}$th and $\frac{1}{16}$th, it is probable there would be but few purchasers. It is these considerations, I believe, and not the uselessness of higher powers, that make our opticians say nothing is to be gained by increasing the power of the object-glass.

Mr. Wenham will, I hope, consider it his high privilege to show, not only that higher powers *are useful*, but that they may be sold at moderate, yet remunerative, prices. No one is more ready than I to admit that the labourer is worthy of his hire, but if we are to have (as I hope we shall have) glasses of much higher power than those now made, and are to take the denominator of the fraction* expressing their focal length as the number of pounds sterling of their price, it is certain few will be willing, even if able, to incur so large an outlay upon a single object-glass.—J. MITCHELL, Lieutenant, Madras Army.

* Powell's 1-16th costs £16. At this rate, a 1-50th, of course, would be £50, a price that would place it beyond the reach of any but the most wealthy. There is something that I, at this distance, cannot understand in the difference of prices by different makers. Powell and Lealand charge 10 guineas for a 1-12th, and Ross £18. But no one will say that one glass performs better than the other—a bit of information, by the way, that would be useful to people in the colonies.

ZOOPHYTOLOGY.

Descriptions *of* New Polyzoa *from* Ireland.

By Rev. Thomas Hincks, B.A.

The new species of Polyzoa which are described in this paper have been obtained from material dredged in deep water, off the coast of Antrim, by Mr. Hyndman of Belfast, whose researches, as a member of the North of Ireland Dredging Committee, appointed by the British Association, have yielded so many valuable results.

Sub-order Cheilostomata.

Fam 1. Membraniporidæ.

Gen. 1. *Membranipora.*

1. *M. imbellis*, n. sp., Hincks. Plate XXX, fig. 1.

Cells ovate, broad below, with a membranous covering (no calcareous expansion); margin raised, much thickened, and beaded. Ovicell very prominent, frosted, with a raised edging round the front. No spines nor avicularia.

The examination of a large number of specimens from various localities, exhibiting a striking uniformity of character, has convinced me that this form should be accounted a species, and that it is not a mere variety of *M. Flemingii*.

I have never detected, even in the youngest and freshest specimens, any trace of spines or avicularia. The polyzoary is generally dull and opaque, and coarse in texture.

The size and distinctness of the cells, the absence of the calcareous expansion, the shape of the ovicell, and the want of spines and avicularian appendages are constant characters, which separate this species from *M. Flemingii*.

Common on shell, &c. Coast of Antrim, *Mr. Hyndman*; Scotland (west coast); Devon.

Gen. 2. *Lepralia.*

1. *L. alba*, n. sp., Hincks. Plate XXX, figs. 2, 2 *a*.

Cells sub-ovate, broad, somewhat depressed, granular; mouth rounded above, lower margin straight, with a notch in the centre; an avicularium on each side, about half-way down the cell; mandible acute, pointing upward.

Ovicell small, depressed, closely united to the cell above, surface finely granular.

On shell, coast of Antrim.

2. *L. eximia*, n. sp., Hincks. Plate XXX, figs. 3, 3 *a*.

Cells large, ovate, distinct, granular, punctured round the margin; mouth sub-quadrate, with a raised peristome, rising into a point at each side, a broad, rounded denticle within the lower margin. Ovicell globose, prominent, punctured.

This fine species grows in irregular, lobulate patches. My specimens exhibit neither spines nor avicularia.

On shell, coast of Antrim.

3. *L. discoidea*, Bk. Plate XXX, figs. 4, 4 *a*.

Cells in straight radiating series; immersed at the base, sub-erect above; surface punctured frosted; orifice small, suborbicular, with a sinus below, peristome raised; 4 to 6 marginal spines above; an avicularium on one or both sides of the cell; mandible elongated linear, obtuse, directed downwards and outwards. Ovicell recumbent, punctured, its sides prolonged, so as to surround the mouth.

Hab.—Antrim, on shell, *T. Hincks*; Madeira, *J. Y. Johnson*; Shetland, *Barlee*.

This species has been figured twice already in former parts of Zoophytology, but on both occasions from specimens in which the true characters were not displayed.

An amended character, therefore, and a more correct representation of the perfect form, is now given. Having been furnished by Mr. Busk with specimens of the same species, recently received by him from Madeira, through the kindness of Mr. J. Y. Johnson, I am fully satisfied of the identity of the Madeiran and Irish forms.

The characters above assigned are usually to be found only on the marginal cells of the patch, which are also in many cases double the size of the older or more central cells; in the latter also the peculiar avicularia are almost invariably wanting, being replaced in most instances by a single, smaller, imperfect avicularium, placed rather to one side on the front of the cell immediately below the mouth. But it is very often the case that this organ is wholly wanting, when the species presents the aspect under which it was formerly depicted.

4. *L. Woodiana*, Busk.

This species has been lately described and figured by Mr. Busk in his 'Monograph on the Polyzoa of the Crag' (p. 42, pl. vii, figs. 1 and 3), and was only known as a fossil, previous to its occurrence amongst Mr. Hyndman's Antrim dredgings. From this rich material I have obtained one or

two specimens on shell, which correspond in all respects with Mr. Busk's figure. *L. Woodiana* must, therefore, take its place as a member of our recent Fauna.

Fossil.—Coralline Crag (*Searles Wood*).

Recent.—Coast of Antrim; ? Madeira, *J. Y. J.*

There is every probability that many more of the Crag forms may be obtained by careful investigation, and those who may have opportunities of dredging, especially in deep water, should be on the look-out for them. Mr. Busk's admirable Monograph, published by the Palæontographical Society, affords a ready means of identifying the species.*

5. *Lepralia Landsborovii*, Johnston.

The description of this species in the 'British Zoophytes' was founded on a single specimen, supplied by Dr. Landsborough, which is preserved in the British Museum. This specimen is old and worn and by no means characteristic, and it is not surprising that Dr. Johnston's diagnosis should have been so imperfect and unsatisfactory. Much difficulty has been experienced in determining what form he had in view, and there has been more than one claimant for the honour of bearing the name.

In his 'Catalogue,' Mr. Busk has given a very admirable figure (pl. cii, fig. 1) of the veritable *L. Landsborovii*, but has referred it to *L. reticulata*. A comparison of the form represented in this figure (which I have procured abundantly) with Dr. Johnston's specimen, has satisfied me of their identity.

The following is an amended description of the species:

Lepralia Landsborovii, Johnston, Brit. Zooph., 2d edit., p. 310.
" " Busk, Catalogue of Brit. Mus. Polyzoa, part ii, page 66, plate lxxxvi, fig. 1 (taken from the Brit. Mus. imperfect specimen); plate cii, fig. 1 (referred to *L. reticulata*).

Cells ovate-elongate, separated by raised lines; surface lustrous, thickly covered with punctures; mouth circular, a denticle within the lower margin, peristome raised, with a spout-like sinus below, enclosing a small avicularium, with a rounded mandible. Ovicell globular, prominent, punctured.

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* Since the above was written, Mr. Busk has furnished me with specimens of a new Madeiran Lepralia, so closely resembling *L. Woodiana* in all essential characters, that I am strongly inclined to agree with him that the two are identical. Thus is added another link to the already numerous ones connecting the southern and western and north-western British Polyzoa, with those belonging to the Mediterranean Fauna, and to that of the Crag.

Dr. Johnston has accurately described the walls of the cells as "thin, glassy, and hyaline, thickly dotted with small perforated granules." In fresh specimens there is a silvery sheen over the surface of the polyzoary. The *avicularium* is placed within the projecting, spout-like sinus, into which the peristome is prolonged below, and behind it is a single denticle. The mandible of the avicularium is rounded.

The *ovicell* is globose and punctured, and the sides of the opening uniting with the peristome give a hooded appearance to the cells on which it is developed.

My finest specimens of this *Lepralia* were dredged off the Great Orme's Head on the coast of North Wales, and were some compensation for the general barrenness of the ground. It occurred here in great abundance, commonly encrusting masses of the sand-tubes belonging to a species of *Sabella*. Over these it spread luxuriantly in large, sub-circular, and glistening patches, occasionally rising into foliaceous expansions. I have also met with it in Devonshire, and amongst Mr. Hyndman's dredgings from the coast of Antrim.*

Fam. 2. CELLEPORIDÆ.

Gen. 1. *Cellepora*.

1. *C. armata*, n. sp., Hincks. Pl. XXX, fig. 5.

Polyzoary adnate, spreading; cells smooth, sub-erect (except towards the margin of the polyzoary), ventricose, distinct; orifice orbicular, slightly produced below, peristome thin and raised; a stout rostrum in front, with an avicularium at one side, immediately below the apex, mandible acute and pointing upward; large spoon-shaped avicularia distributed over the polyzoary, in the intercellular spaces. Ovicell smooth; walls entire.

In this species, the avicularium is placed at the top of the rostrum, looking to one side. The broad triangular mandible points upward. The rostrum is much stouter and more obtuse than in *C. pumicosa*.

Localities.—Coast of Antrim, on shell, *Mr. Hyndman;* Dogger Bank and South Devon, *T. H.;* Madeira, *J. Y. J.*, 1860.

2. *C. avicularis*, n. sp., Hincks.

A *Cellepora* occurs in considerable plenty on Zoophytes from Ireland, which seems to be undescribed.

The following are its characters:

Polyzoary encrusting or spreading, variable in its mode of growth; cells ovate, ventricose, smooth; orifice orbicular, with a deep sinus in

* *Vide* Report of Belfast Dredging Committee, in the British Association volume for 1858, p. 293.

front, a short, conical rostrum below the mouth, with an avicularium, set obliquely, near the top of it, mandible acute; in fertile cells, a process on each side, just below the ovicell, and attached to it, bearing an oval (?) avicularium. Ovicell prominent, with large punctures, somewhat semicircularly disposed. Spatulate avicularia thickly scattered amongst the cells.

Occasionally there occurs on the polyzoary a very stout, conical rostrum, bearing a large avicularium, with broad, triangular mandible.

Localities.—Ireland, encrusting stems of Zoophytes, &c.

Sub-Order CYCLOSTOMATA.

Fam. 1. TUBULIPORIDÆ.

Gen. *Alecto.*

1. *A. incurvata*, n. sp., Hincks. Plate XXX, fig. 6.

Polyzoarium adnate, linear, curved, tapering; cells biserial, alternate, bent towards the side, orifices opening out laterally; surface obscurely punctate.

Polyzoarium closely adnate, narrow, unbranched, more or less attenuated towards the point of origin; the cells are biserial and alternate (except towards the base of the polyzoary, where they form a single row), and separated by a median line; they bend towards the side, and project a little beyond the polyzoary, the orifices opening out laterally.

On stones, coast of Antrim (deep water), not uncommon.

The Antrim dredgings have yielded a large number of the *Cyclostomata*, belonging to the genera *Tubulipora* and *Alecto*, which I am obliged to reserve for future examination.

Sub-Order CTENOSTOMATA.

Fam. VESICULARIIDÆ.

Gen. *Farrella.*

1. *F. dilatata*, n. sp., Hincks. Plate XXX, fig. 7.

Cells tubulous, sessile, stout, of equal size throughout, opaque, springing from one extremity of a fusiform expansion of the fibre, which is closely adherent, and set round with a number of flattened, spinous projections.

In this species the delicate, creeping fibre swells out here and there into cell-like expansions, fusiform, adherent, and furnished with a variable number of flattened, spinous processes. The cells spring from the larger end of these swellings. They are stout, sessile, and not contracted at the base, and of a dark, horn colour when dried. The clavate and spinous expansions are analogous to the cell-bearing enlargements of the fibre in *Ætea*.

Isle of Man, on shell, *T. H.*; Antrim, deep water, *Mr. Hyndman.*

In the 'Belfast Dredging Com. Report' for 1858, I have recorded this species as *Avenella dilatata*. But the *Avenella* of Sir John Dalyell is a very doubtful genus, and I prefer, for the present, to refer it to *Farrella*, as defined by Mr. Busk, in the 'Micr. Journal,' vol. iv, p. 93.

II. Catalogue *of the* Polyzoa *collected by* J. Y. Johnson, Esq., *at* Madeira, *in the years* 1859 *and* 1860, *with descriptions of the* New Species. By G. Busk, F.R.S.

I. Cheilostomata.

Fam. 1. Catenicellidæ.

Gen. 1. *Catenicella*, Blainv.

1. *C. elegans*, Bk.

Hab.—Madeira, on fishermen's baskets, abundant, *J. Y. J.*; (?) Mediterranean, *Savigny*; South Africa; Australia; New Zealand.

Fam. 2. Salicornariidæ, Bk.

Gen. 2. *Salicornaria*, Cuv.

1. *S. Johnsoni*, Bk.

Hab.—Madeira, *J. Y. J.*; Shetland, *Barlee*.

Fam. 3. Cellulariidæ, Bk.

Gen. 3. *Scrupocellaria*, Van Beneden.

1. *S. Maderensis*, n. sp.

Cellulis elongatis: aviculario parvo; orificio ovali, peristomate simplici glabro; operculo suborbiculari glabro integro; spinis marginalibus sex, equidistantibus; ovicellulâ glabrâ non punctatâ.

Cells elongated; avicularium small; orifice oval, peristome simple, not granular; pedunculate operculum sub-orbicular, smooth, entire; six equidistant marginal spines above; ovicell smooth, not perforated.

Hab.—Madeira, *J. Y. J.*

This species differs from *S. pilosa*, Audouin (sp.), in several respects. 1st. In the form of the cell, which in that species is represented as elongated, and of nearly equal diameter throughout, especially as viewed on the dorsal aspect. 2dly. In the disposition of the marginal spines, which in *S. pilosa* are depicted as four on the upper and outer margin, and a single one some distance apart on the inner border of the orifice. 3dly. In the ovicell, which in *S. pilosa* appears to be perforated. They agree somewhat in general aspect, in

the considerable number of spines, in the simple, smooth peristome, and in the form of the pedunculate operculum.

As the only specimen brought on this occasion by Mr. Johnson is small and imperfect, and has moreover been injured since it came under my inspection, I have deferred making a figure of the species until further specimens, as I hope, may enable me to do so with greater advantage.

2. *S. Macandrei*, Bk.

This species may be at once distinguished by the broad, granular peristome, and contracted, sub-orbicular form of the orifice. In the B. M. Cat., I have described and figured it as being usually without marginal spines, but in the present instance it has two or three on the outer and upper margin, and one or sometimes two on the inner. From *S. Delilii*, Aud. (sp.), it is distinguished by the total absence of anterior avicularia. The present species may perhaps be identical with *S. ciliata*, Aud. (sp.) ('Egypt,' pl. xii, fig. 2), but if so, the drawing does not exhibit the granular peristome, nor the toothed, radical tube; and moreover, in that species the lowest marginal spine on the outside is represented as forked.

Fam. 4. CABEREIDÆ, Bk.

Gen. 4. *Cabrera*, Bk.

1. *C. Boryi*, Audouin.

Thus adding another stage in the progress of this species from the southern hemisphere towards the British Channel.

Fam. 5. SCRUPARIIDÆ, Bk.

Gen. 5. *Scruparia*, Oken.

1. *S. diaphana*, n. sp. Pl. XXXI, figs. 1, 1 *a*.

Polyzoario libero, suberecto, irregulariter ramoso; cellulis elongatis, diaphanis, antice sparsè perforatis; orificio orbiculari, infra sinuato, peristomate valde producto superne emarginato; ramis, cellulæ parte superiori uno latere surgentibus.

Polyzoarium free, phytoid, sub-erect, irregularly branched; cells elongate, walls transparent, sparsely punctured in front; orifice orbicular, sinuated below, peristome thin, produced, notched above; branches springing from one side of cell at the top.

Hab.—Madeira, abundant, *J. Y. J.*

A beautiful and very distinct form. From the extreme transparency of the walls, they appear at first sight as if they were composed simply of a chitinous substance, but when incinerated, sufficient calcareous matter is left perfectly to retain the form of the cell.

From the peculiar delicacy of the walls this species would afford perhaps the best subject yet met with for the study of the living animal in the cheilostome Polyzoa.

Gen. 6. *Ætea*, Lamx.

1. *Æ. truncata*, Bk.

Fam. 6. BICELLARIIDÆ, Bk.

Gen. 7. *Bugula*, Oken.

1. *B. gracilis*, Bk.

2. *B. avicularia*, Lk. (sp.)

Fam. 7. FLUSTRIDÆ.

Gen. 8. *Carbasea*, Gray.

1. *C. ligulata*, n. sp. Pl. XXXI, fig. 2.

Polyzoario phytoideo, erecto, ramoso, ramis irregularibus, ligulatis, gracilibus, rectis, divaricatis; cellulis, bi-triseriatis, elongatis, fusiformibus, subcylindraceis, inferne attenuatis, clausis, poro centrali lunato, et duobus minoribus simplicibus, infra orificium, ornatis, lateribus punctatis, dorso glabro; orificio semicirculari, labio inferiori recto, superiori spinis marginalibus sex munito; ovicellulis, subglobosis erectis, superficie delicatule rugosis.

Polyzoarium phytoid, branched; branches irregular, very slender, straight, divaricate; cells bi-triserial, elongated, fusiform, sub-cylindrical, tapering downwards, closed in front, with a lunate pore in the centre, and two smaller, round, simple pores immediately below the orifice; orifice semicircular, lower lip straight, upper margin furnished with six spines; ovicell sub-globose, erect, finely wrinkled on the surface; cells smooth and rounded behind.

Hab.—Madeira, *J. Y. J.*

This very peculiar and well-marked species is at once distinguished from all its congeners by the habit of the polyzoary, which is thoroughly phytoid, except that the branches are all in one plane. At first sight it resembles a fucus or sertularian zoophyte. On the sides of the branches are frequently placed radical tubes, as in several others of the Flustridæ.

Fam. 8. MEMBRANIPORIDÆ.

Gen. 9. *Membranipora*, Blanv.

1. *M. Rosselii*, Aud. (sp.)

? 2. *M. Lacroixii*, Aud. (sp.)

I am not quite sure that this form is rightly referred to *M. Lacroixii*, but it so closely resembles that Mediterranean species as to render their identity highly probably. Whether this may be the case or not, there can, however, be no

doubt that the present form is the same as *M. irregularis*, D'Orbigny ('Amer. Mérid.,' pl. viii, figs. 5, 6), with which may also, perhaps, be associated the same author's *M. simplex* (ib., figs. 7, 9). The cells are for the most part oval, not contiguous, very irregular in size and position. The margin is granular, and wholly unarmed, and there is no appearance of avicularia in any part of the two or three patches submitted to examination.

The following may be taken, I think, as the synonymy of this protean species:

M. Lacroixii, Aud.; Bk.; Alder.
M. irregularis, M. simplex ? D'Orb.
Flustra distans, Hassall; Johnst.; W. Thompson (Belf.)

3. *M. lineata*, Linn. (sp.)
4. *M. Calpensis*, Bk.

Gen. 10. *Lepralia*, Johnst.

1. Armatæ.

a. With oral spines.

1. *L. discoidea*, Bk.

For a full account and corrected character of this species, see Mr. Hincks's observations, *supra*.

2. *L. innominata*, Johnst.
3. *L. radiata*, Moll.

I have some doubts whether these two may not, strange as it may seem, prove to be varieties of each other, in which case Moll's name will, of course, have precedence.

4. *L. porcellana*, n. sp. Pl. XXXI, fig. 3.

Cellulis latis, subrhomboideis, immersis, superficie rugosâ, granulosâ, nitidâ: orificio superne rotundato, infra coarctato, labio inferiori integro, superiori spinis tribus, sæpius absentibus, munito; avicularia, mandibulo triangulari acuto superne et ad externum spectante, utroque lateri cellulæ posito.

Cells broad, ovate or rhomboidal, deeply immersed; surface uneven, bossed, granular, polished, porcellanous; orifice rounded above, contracted below, with an entire lower lip, and three marginal spines above, often absent or to be found only on the younger cells; a raised avicularium on each side of the cell, about the middle; the mandible triangular acute, pointing upwards and outwards.

Hab.—Madeira, on shell, *J. Y. J.*

The remarkably polished or porcellanous surface gives the patches formed by this *Lepralia* so peculiar an aspect,

that it may, by that character alone, be at once distinguished. In the younger patches the surface is shining and glossy, and, in this condition, the three marginal spines are usually present; and the outline of the orifice is distinct and free. Very soon, however, the walls appear to thicken, and to become irregularly bossed, especially around the orifice, which is thus lodged in a sort of irregular depression.

5. *L. vulgaris*, Moll.

6. *L. marsupiata*, n. sp. Pl. XXXI, fig. 4.

Cellulis ovatis, superficie granulosâ, obscure punctatâ; orificio semicirculari, labio inferiori recto, integro, superiori spinis sex validis, articulatis quarum infimis furcatis armato; poro lunato medio infra orificium rostro poculiformi obtecto; ad unum latus cellulæ vibraculo, setâ nigrâ.

Cells ovate; surface granular, with scattered fine puncta; orifice semicircular or arched above, lower lip straight, entire; six large articulated spines on the sides and above, the lowermost of which on either side is forked at the extremities; a lunate pore in the middle, a short distance below the orifice, protected below and on the sides by a pouch-like rostrum; a long, slender vibraculum, with a black seta on one side of the cell, towards the upper part.

Hab.—Madeira, on shell, *J. Y. J.*

A very well-marked and beautiful species. The marginal spines are distinctly articulated, as in *L. Gattyæ*, Bk., and one or two others, by a horny substance of a black colour. They are consequently readily broken off.

7. *L. Woodiana*, Bk.

This agrees in all essential characters with *L. Woodiana* of the Crag, and which has been found in the living state in Ireland by Mr. Hincks. The Madeiran specimens, however, differ in some respects, and chiefly in the greater development of the cup-like peristome, and the apparently larger size of the avicularia on the shoulders of the cell. Another difference also may be found in the apparent absence of the series of marginal punctures observable in *L. Woodiana*. If it should prove a distinct species, it will probably be found to coincide with *L. Dutertrei*, Audouin (sp.)

8. *L. sceletos*, Bk.

β. No oral spines.

L. unicornis, Johnst.

1 *L. alba*, Hincks.

11. *L. concinna*, Bk.

2. Inarmatæ.

α. Without oral spines.

12. *L. Mangnevilla*, Aud. Pl. XXXI, fig. 5.

Cellulis ovatis, superne liberis suberectis, crebrè punctatis; orificio superne arcuato infra coarctato, peristomate producto, infundibuliformi in cellulis sterilibus integro in fertilibus superne alte emarginato; ovicellulâ parvâ, recumbente, immersâ.

Cells ovate, free and sub-erect above, surface uneven, punctured; orifice arched above, contracted towards the lower part, surrounded by a much raised, infundibuliform or sub-tubulose peristome, which is entire in the sterile and deeply emarginate above in the fertile cells; ovicell small, recumbent, immersed.

Hab.—Madeira, *J. Y. J.;* Mediterranean, *Savigny.*

From a general resemblance to Savigny's figure, I venture to refer the present species to Audouin's *L. Mangnevilla;* but at the same time, since some doubt may be entertained on the subject, I have thought it best to give a figure and diagnosis of the Madeiran form.

In the figure, the surface is incorrectly represented more as if it were granular than merely uneven and punctured.

(*To be continued.*)

DESCRIPTION OF PLATES XXX & XXXI.

PLATE XXX.

Fig.

1.—*Membranipora imbellis.* (p. 275.)
2.—*Lepralia armata.* (p. 275.)
2 *a.*—Ovicell.
3, 3 *a.*—*L. eximia.* (p. 276.)
4.—*L. discoidea,* × 25 diam. (p. 276.)
4 *a.*— „ × 50 diam. (p. 276.)
5.—*Cellepora tubigera?* (p. 278.)
6.—*Alecto incurvata.* (p. 279.)
7.—*Farrella dilatata.* (p. 279.)

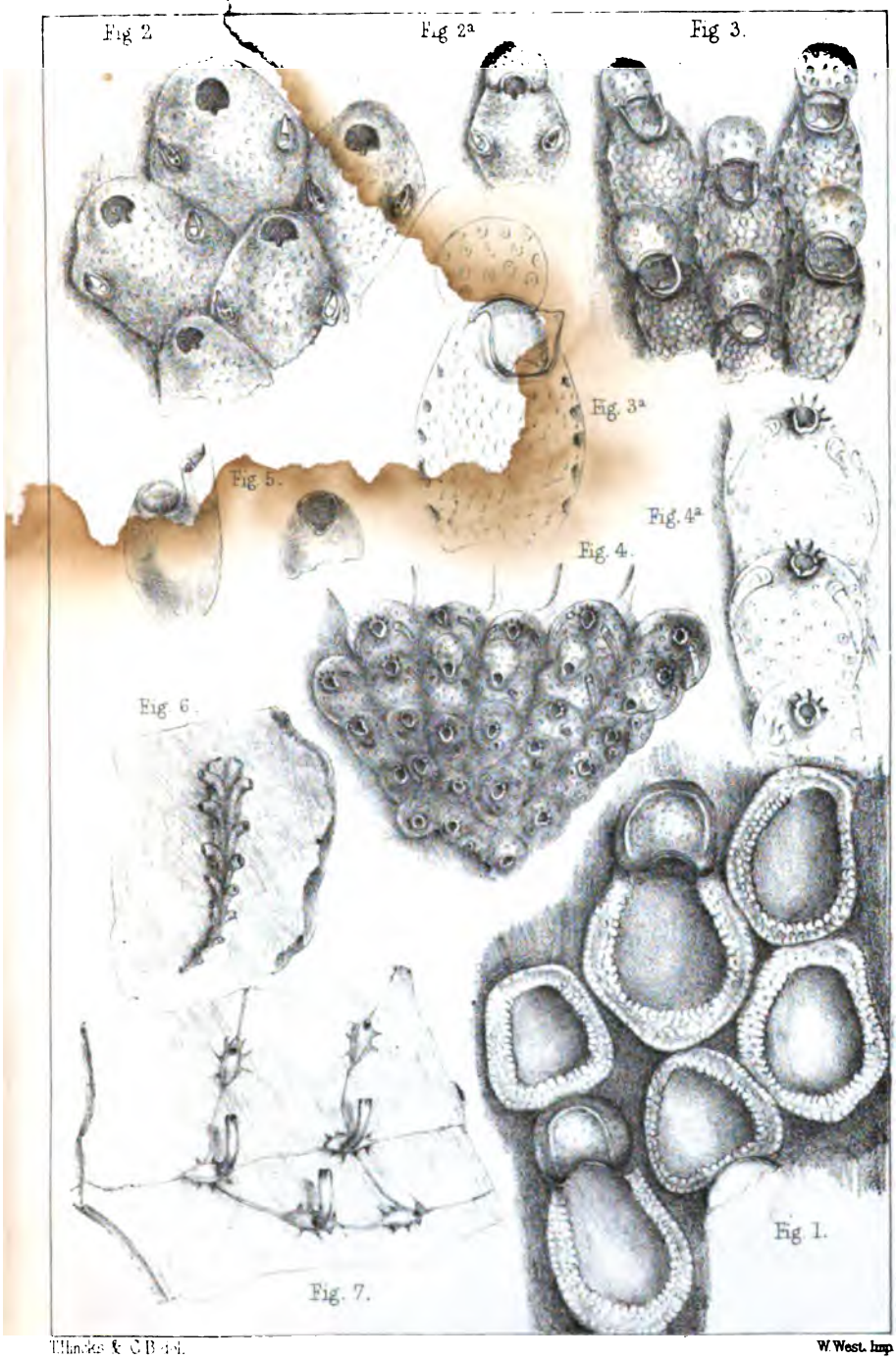
PLATE XXXI.

Fig.

1.—*Scruparia diaphana.* (p. 281.)
2.—*Carbasea ligulata.* (p. 282.)
3.—*Lepralia porcellana.* (p. 283.)
4.— „ *marsupiata.* (p. 284.)
5.— „ *Mangnevilla?* (p. 284.)

ZOOPHYTOLOGY.

Plate XXX.

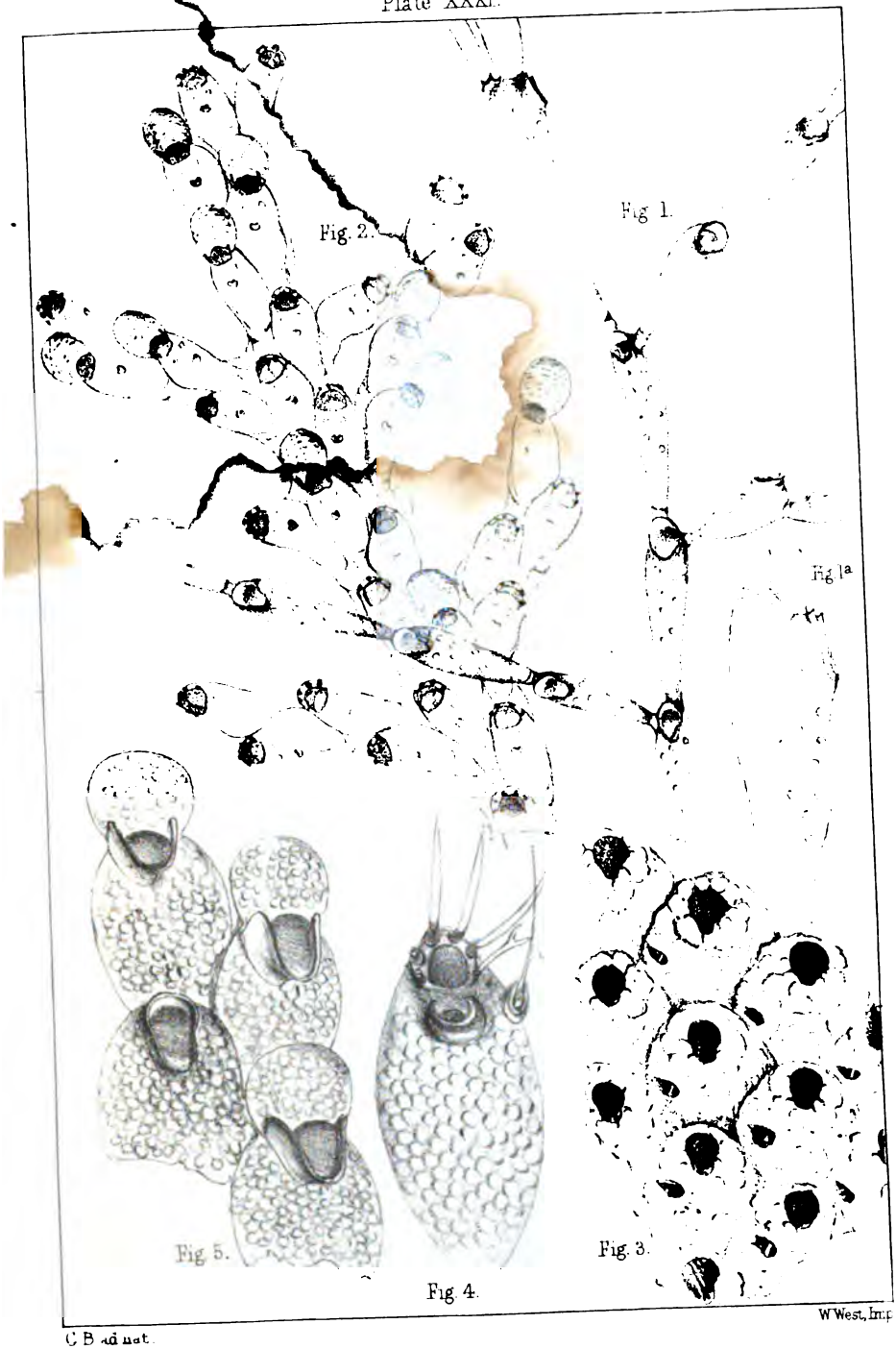


T. Hincks & C. B. del.

W. West. Imp.

ZOOPHYTOLOGY.

Plate XXXI.



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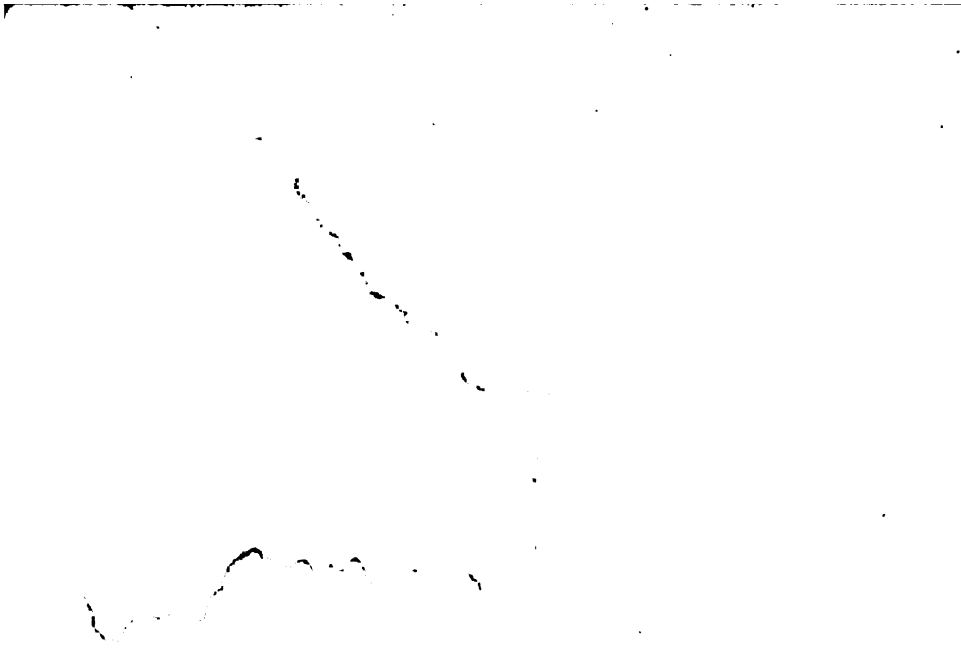
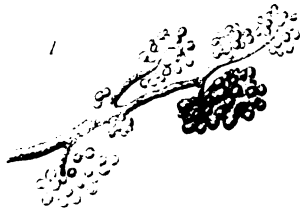
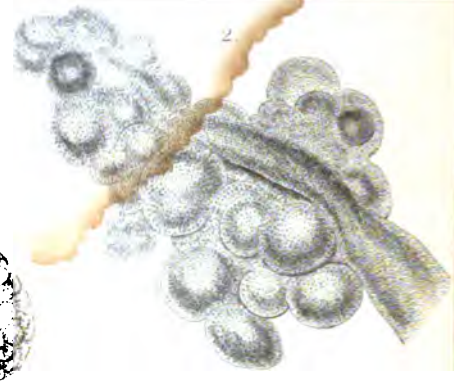
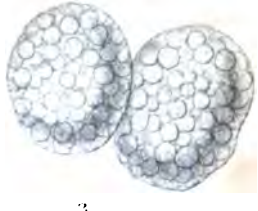
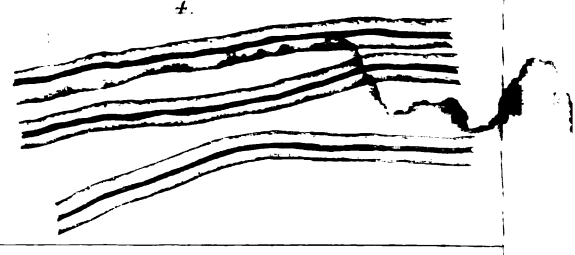


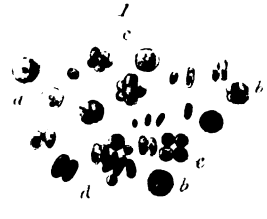


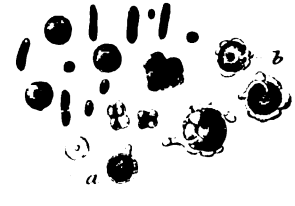






W. Turner del.





DESCRIPTION OF PLATE X,

Illustrating Dr. J. Braxton Hicks's paper on Contributions to Development of the Gonidia of Lichens, in relation to the Unicellular Algæ, &c.

Fig.

1.—*Chlorococcus*.
- *a*, *a*. Mature, quiescent cell.
- *b*, *b*. Segmentation, radiating from centre.
- *c*, *c*. Advanced condition of same.
- *d*, *d*. Binary and quaternary subdivision.
- *e*. Quaternary subdivision, reverting to mature stage.

2.—*Chlorococcus* in various stages.
- *a*. First appearance of growth of fibre.
- *b*, *b*, *b*. More advanced condition.

3.—Mature, quiescent gonidium.

4.—Formation of *soridium*.

5.— „ „ segmentation proceeding at same time with fibre-growth.

6.—Oval cells, the result of segmentation going on to binary subdivision.

7.—*Soridium* of *Chlorococcus*, and also of *Lichen*.

8.—Contents of a *soridium* pressed apart.

9.—Single, dormant *soridium* (section of).

10.—*Soridium* in which segmentation has proceeded a certain distance and become dormant (section of).
- *a*. Segments, numerous.
- *b*, *b*. Globular form of subdivisions.

11.—Active bodies in cavities in the fibres.

Figs. 1 to 4 illustrate Mr. Turner's paper on the Minute Structure of the Pancreas, and on the Axis-cylinder of Nerves.

Fig.

1.—Portion of injected pancreas under a low power.

2.—Part of the same, with a much higher power.

3.—Lobules detached in course of preparation from a portion of pancreas into which the injection has not entered, showing the globular epithelium with which they are filled.

4. Portions of nerves in which the axis-cylinder has become coloured by carmine, the sheath remaining quite free from colour.

DESCRIPTION OF PLATES XI & XII.

PLATE XI,

Illustrating Mr. Archer's paper on the Occurrence of Zoospores in the Family Desmidiaceæ.

Fig.

1, 2, 3, 4.—*Docidium Ehrenbergii*, with lateral projections in different stages of development.

5.—Parasitic growth (*Pythium*) upon *Closterium lunula*.

6.—Mycelioid growth within *Closterium lunula*, R.

7.—*Arthrodesmus Incus*.

8.—*Cosmarium Portianum*; front view.

9.— „ „ end view.

10.—*Xanthidium Smithii*; front view.

11.— „ „ side view.

12.— „ „ end view.

PLATE XII,

Illustrating Professor Huxley's paper on the Structure of the Mouth and Pharynx of the Scorpion.

Fig.

1.—Longitudinal vertical section of the cephalo-thorax of a Scorpion, showing the pharynx, œsophagus, nervous centres, and the large eyes, in their natural relations.

2.—Dorsal view of the cephalo-thorax of a Scorpion, opened and dissected, so as to show the apodemata, and the anterior portion of the alimentary canal, with the pharyngeal muscles.

3.—The chitinous lining of the anterior part of the alimentary canal, the integument of the labrum, and the basal processes of the first maxilla.

4.—The chitinous lining of the pharyngeal sac, viewed from above.

5.—A transverse section of the same, taken along the line *x y* (fig. 3).

6.—The region of the pharyngeal sac near the commencement of the œsophagus.

The letters have the same significations throughout:—*a*, mouth; *b*, labrum; *c*, pharynx; *d*, œsophagus; *e*, salivary duct; *f*, diaphragm; *g*, eye and ocular nerve; *h*, subœsophageal ganglion; *i*, antenna; *k*, maxilla; *l*, mandible; *m*, apodeme; *n*, pharyngeal muscles; *o*, sub-oral transverse thickening of the chitinous integument; *p*, valve (?) of the pharynx; *x y*, line along which the section in fig. 5 is taken.

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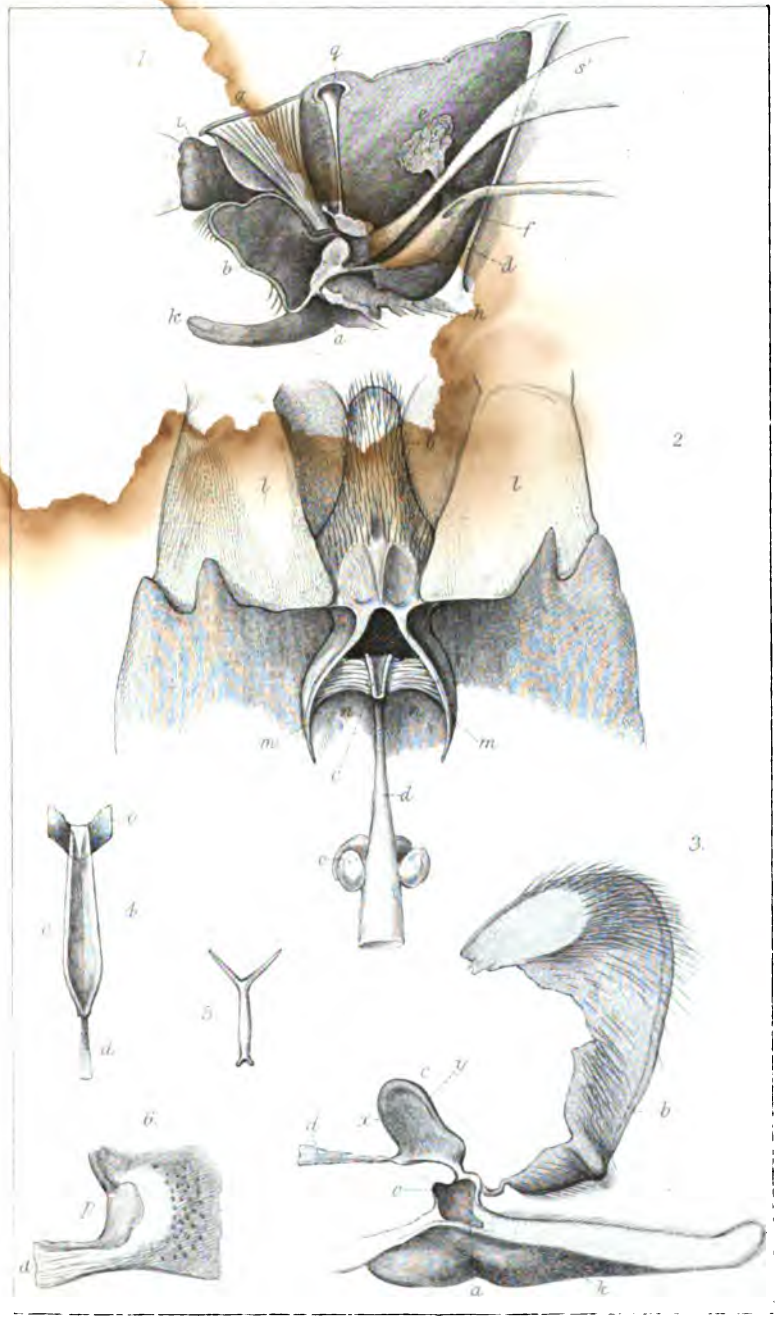

Dr. H. del. Tuffen West sc.

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